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WORK PLAN
LEASE SUSPENSION PERIOD
ENVIRONMENTAL PROGRAMS

November 1, 1976

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October 31, 1977

WHITE RIVER SHALE PROJECT
Federal Prototype Oil Shale Leases
Ua and Ub

December 1976

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WORK PLAN

LEASE SUSPENSION PERIOD ENVIRONMENTAL PROGRAMS

November 1, 1976 - October 31, 1977

WHITE RIVER SHALE PROJECT

FEDERAL PROTOTYPE OIL SHALE LEASES Ua AND Ub

December 1976

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Section 1.0

SUMMARY

The "Work Plan -- Lease Suspension Period Environmental Programs" addresses the conditions which accompanied the Notice of Suspension of Operations on Tract Ua and Tract Ub. It presents the activities planned to occur between November 1, 1976 and October 31, 1977. Specific activities planned include completion of the two-year Environmental Baseline Monitoring Program, submission of the Final Report for the two-year Baseline Program, implementation of an Interim Environmental Monitoring Program, continuation of the Revegetation Research Program, and submission of a Progress and Final Report covering the preceding activities.

Section 2.0

INTRODUCTION

The White River Shale Project (WRSP) was formed in 1974 to operate the joint venture development of the two Federal Prototype Oil Shale Lease Tracts (Ua/Ub) in Utah. WRSP is responsible to Sunoco Energy Development Company, Sohio Petroleum Company and Phillips Petroleum Company for carrying out the planning and implementation of development activities.

Two significant tasks have been completed by WRSP since work under the leases began. First, the first year of the required two-year Environmental Baseline Program was completed in January of 1976. The full program will be completed by January of 1977. Second, the Detailed Development Plan required by the leases was submitted to the U. S. Geological Survey - Area Oil Shale Supervisor (AOSS) in June of 1976. This plan describes the activities, timing and results expected for development of Tract Ua/Ub into a 100,000 barrel per day oil shale processing facility.

Operations under the Ua/Ub leases, however, have been suspended effective November 1, 1976 - November 1, 1977. This effectively postpones the implementation of the program described in the Detailed Development Plan (DDP). The lease terms were suspended because the Environmental Baseline Program detected levels of airborne ozone and non-methane hydrocarbons which exceeded Federal National Ambient Air Quality Standards. This situation precludes proceeding with development as described in the DDP until the regulations are modified or provisions are made for allowing construction of facilities in areas which do not meet air quality standards under natural conditons.

The suspension period, therefore, is an increment of time which did not have a work plan of specific activities called out by the leases or the Detailed Development Plan.

The Notice of Suspension of Operations from the AOSS, however, stipulates what can be done by WRSP during the suspension period. Specifically, the suspension of operations period is subject to the following conditions:

1. Written consent of all bonding companies and/or other sureties shall be submitted to the Mining Supervisor.

2. Lessees will complete the two-year Baseline Data Collection Program and shall submit the data collected to the Mining Supervisor pursuant to the existing approved program.

3. Lessees will submit a final report on the two-year baseline program analyzing the data collected which will include appropriate sections on ecological interrealationships as required by Lease Environmental Stipulation 1(C)(2)(d) within six months following completion of the two-year baseline data collection period.

4. Lessees will implement an interim environmental monitoring program to commence immediately upon the completion of the two-year baseline data program. The purpose of the program is: to maintain continuity of data gathering on critical parameters of the environmental baseline program; to further explore identified problem areas; to provide the Government and the Lessee with further knowledge of environmental conditions on the lease tract, and to permit rapid commencement of operations at the end of the suspension period.

   The interim environmental monitoring program shall be based upon continuing analysis of the data from the baseline program and shall be integrated with that program. The program shall include continued air quality and meteorology at selected stations, hydrologic monitoring at selected surface and ground water stations and biological monitoring of important paramaters in accord with ecological survey methodology.

   Lessee shall submit no later than January 1, 1977, a plan to carry out the interim environmental monitoring program to the Mining Supervisor for his approval. The Lessee will submit reports on the interim monitoring program semiannually.

5. Lessees will maintain facilities and conduct any work on the leased lands authorized by the terms of this Notice of Suspension in accord with the terms of the lease during the period of suspension. Facilities shall not be removed from the leased lands without permission of the Mining Supervisor.

6. Lessees shall continue existing revegetation research programs during the period of suspension.

The purpose of this "Work Plan -- Lease Suspension Period Environmental Programs" is to respond to the above conditions. Item #1 has been satisfied by a review of existing bonding conditions by AOSS. Item #5 is understood by WRSP and does not require a reply. The other conditions, therefore, make up the majority of the material covered by the Work Plan.

The only section that requires specific AOSS approval regards Condition 4, the "Interim Environmental Monitoring Program". Section 4.0 of the Work Plan document presents a plan in accordance with requirements as set forth.

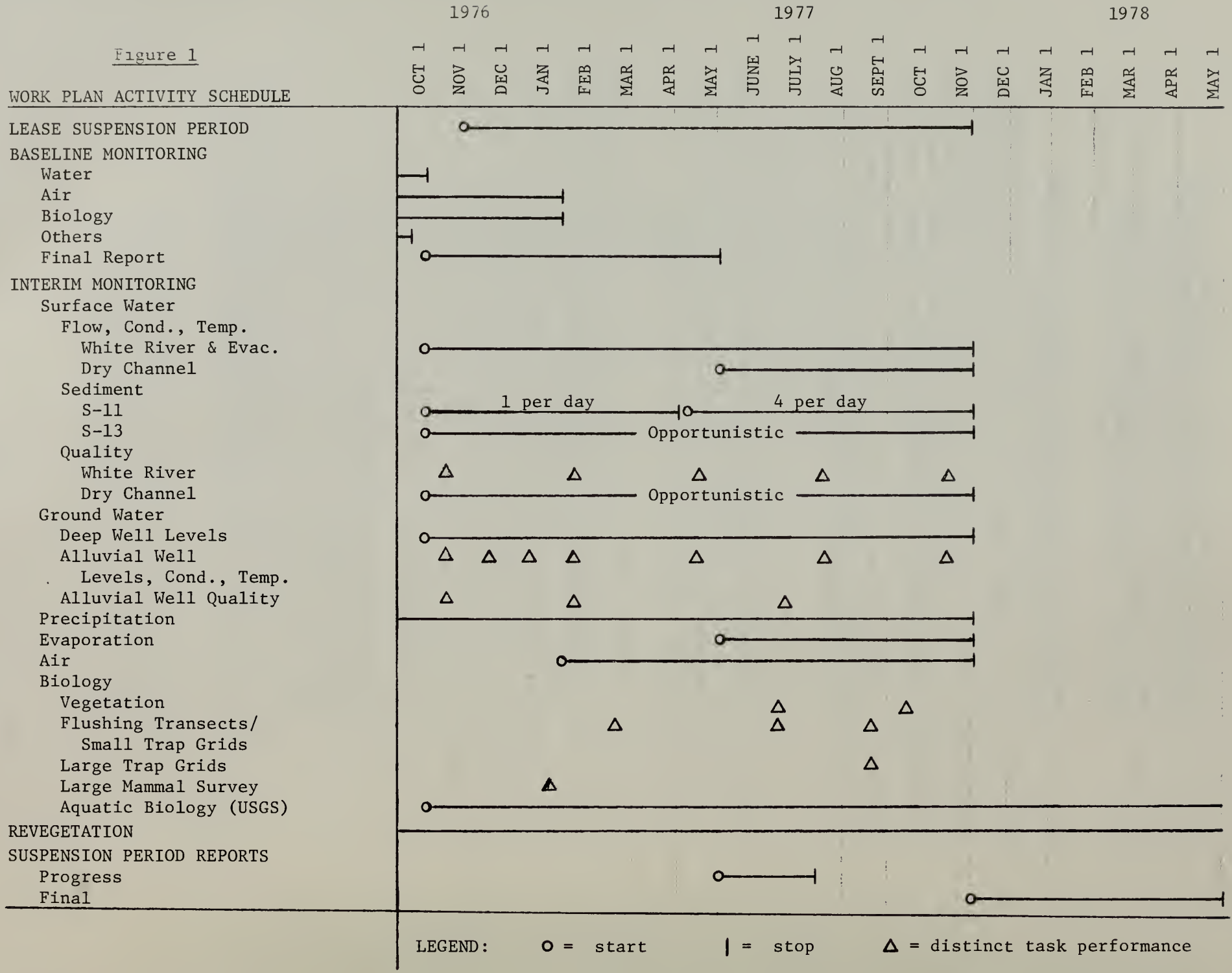
Request is hereby made for the Area Oil Shale Supervisor's approval of the monitoring program in Section 4.0 as proposed, and for notification that the other conditions of the Notice of Suspension will be met through the carrying out of the other programs and activities discussed by the Work Plan.

The Work Plan covers the following areas:

1. Baseline Environmental Monitoring
2. Interim Environmental Monitoring
3. Revegetation Research
4. Suspension Period Reports

Figure 1 shows the schedule of activities in regard to these four areas. The remaining sections of the Work Plan will discuss these four task areas in detail.

Figure 1


1976
1977
1978
OCT 1
NOV 1
DEC 1
JAN 1
FEB 1
MAR 1
APR 1
MAY 1
JUNE 1
JULY 1
AUG 1
SEPT 1
OCT 1
NOV 1
DEC 1
JAN 1
FEB 1
MAR 1
APR 1
MAY 1
WORK PLAN ACTIVITY SCHEDULE
LEASE SUSPENSION PERIOD
BASELINE MONITORING
Water
Air
Biology
Others
Final Report
INTERIM MONITORING
Surface Water
Flow, Cond., Temp.
White River & Evac.
Dry Channel
Sediment
S-11
S-13
1 per day
4 per day
Opportunistic
Quality
White River
Dry Channel
Opportunistic
Ground Water
Deep Well Levels
Alluvial Well
Levels, Cond., Temp.
Alluvial Well Quality
Precipitation
Evaporation
Air
Biology
Vegetation
Flushing Transects/
Small Trap Grids
Large Trap Grids
Large Mammal Survey
Aquatic Biology (USGS)
REVEGETATION
SUSPENSION PERIOD REPORTS
Progress
Final
LEGEND: o = start | = stop Δ = distinct task performance

Section 3.0

BASELINE ENVIRONMENTAL MONITORING PROGRAM

The field work for the required two-year Environmental Baseline Monitoring Program will be completed by January 15, 1977. Thus, part of the suspension period will see continued field work on this program.

Work in regard to the Baseline Program will then shift to data review and report preparation. Evaluation of the Baseline data will continue even after submission of the Final Baseline Report.

3.1 DATA ANALYSIS AND REPORTS

The last Quarterly Baseline Report (#9) for the Baseline Program will be submitted to the AOSS in January 1977.

The Final Environmental Baseline Report is expected to be submitted to the AOSS by May 1, 1977. Figure 2 shows the expected schedule of activities for completion of this report. Appendix A presents the format of presentation planned for the report. All data not previously presented in Quarterly Baseline Reports will accompany the Final Report.

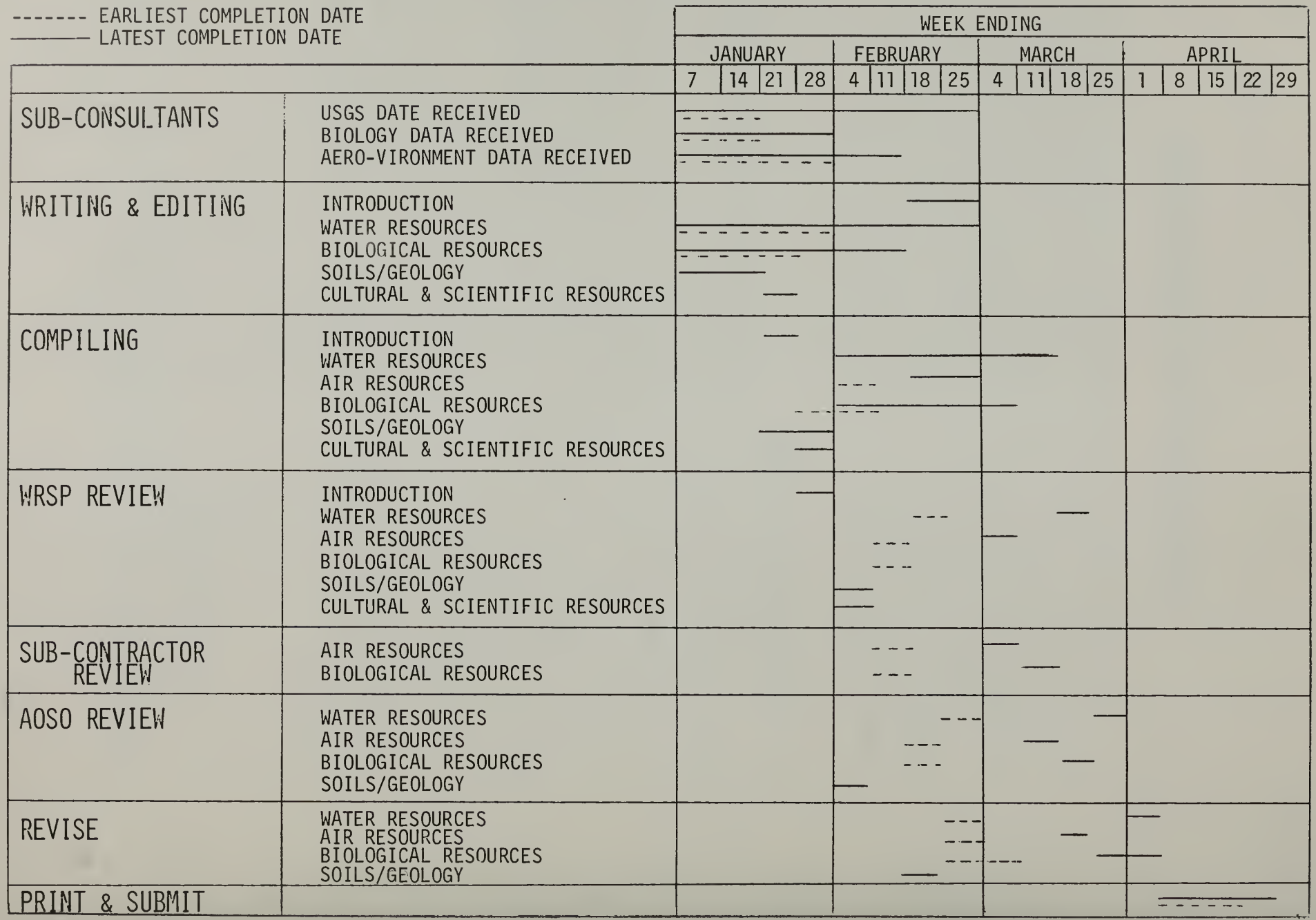
Of particular note in regard to the Final Report is the fact that significant differences between the data base used for the Detailed Development Plan, and that resulting from analysis of the two-year results will be highlighted.

3.2 ONGOING DATA REVIEW

Conclusions drawn from the Final Baseline Report will be compared to Detailed Development Plan discussions following submission of the Final

FIGURE 2

DRAFT SCHEDULE OF COMPLETION
FOR THE FINAL ENVIRONMENTAL BASELINE REPORT



Baseline Report. Modifications, if any, will be made to the approved Detailed Development Plan as required.

The ongoing data review will also provide a basis for evaluating the results of the Interim Environmental Monitoring Program (see Section 4.0). Modifications would be made in this program if the review suggested that different approaches would provide better methods for meeting the objectives of the monitoring effort.

It is expected that the ongoing data review process will involve more groups than just WRSP. The results of these "outside" reviews should be very valuable in regard to evaluating modifications to the Detailed Development Plan and/or future environmental monitoring programs.

Section 4.0

INTERIM ENVIRONMENTAL MONITORING PROGRAM DESCRIPTION

The two-year Environmental Baseline Program will be completed in total by January 15, 1977. (See "Verification Document -- Completion of Two-Year Environmental Baseline Program"). This section will discuss the Interim Monitoring Program required to be implemented after completion of the Baseline Program by the terms of the "Notice of Suspension of Operations under the Lease Terms."

The Interim Monitoring Program's primary purpose is to ensure the continuity of data gathering so as to maintain the applicability of the two-year Baseline survey to future monitoring periods. The program discussed in this section, therefore, will fill the "interim" period between completion of the Baseline survey work and the implementation of the monitoring program to be conducted during oil shale development activities.

An additional purpose of the Interim Monitoring Program is to develop more data in areas of specific concern. One of these areas, for example, deals with the levels of the air quality parameters ozone and non-methane hydrocarbons. Levels of these materials were found to exceed National Ambient Air Quality Standards during Baseline monitoring.

Three aspects of the environment will be monitored during the suspension period. These are air, water and biological resources. Figure 1 summarizes the schedule of monitoring activities.

The remainder of the work plan discussion in this section will address the objectives, methods, data analysis techniques and rationale for the specific monitoring program elements planned for the lease suspension period.

4.1 WATER RESOURCES

The two year water resources Environmental Baseline Monitoring Program was completed October 1, 1976. An "interim" monitoring program was approved by the AOSS in November. This program is now in operation and will be conducted until a program is approved for the lease suspension period.

The United States Geological Survey (USGS) has proposed a water resources data collection program in the Uintah Basin drainage area. Much of this data collection will take place in the immediate vicinity of Tract Ua/Ub. The WRSP Water Resources Interim Monitoring Program is designed to be used in conjunction with pertinent portions of the proposed USGS program. Taken together, the two data collection programs will adequately monitor streamflow, suspended sediment, and water quality at locations on the White River, Evacuation Creek and at the mouths of Southam Canyon, Asphalt Wash and Hell's Hole Canyon.

Alluvial aquifers will be monitored for water levels and quality at locations upstream and downstream of the tract on the White River and on Evacuation Creek and at locations at the mouths of Southam Canyon and Asphalt Wash. Precipitation and evaporation will be monitored at the proposed plant site, in Southam Canyon, and the surrounding area.

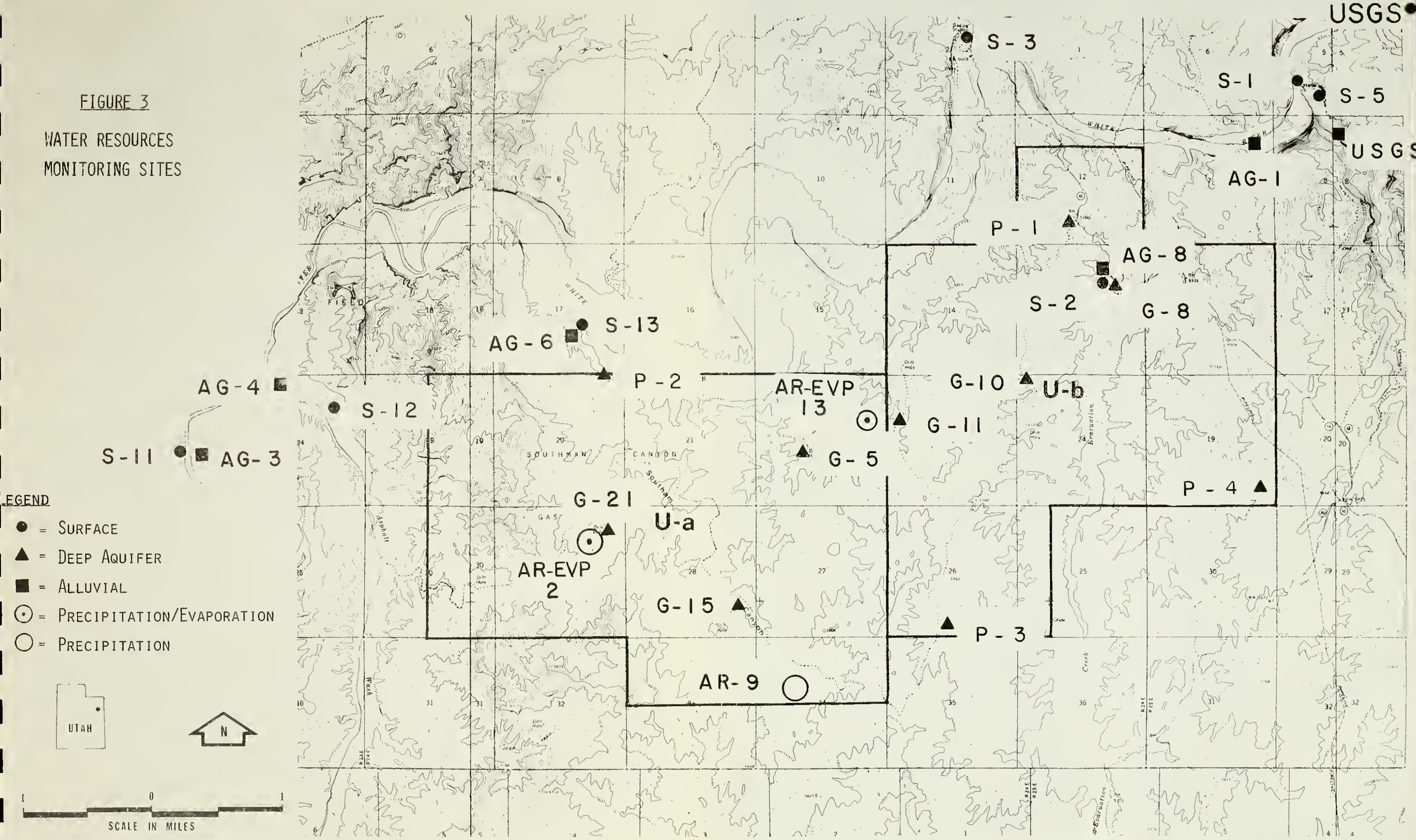
The Birds Nest and Douglas Creek bedrock aquifers will be continuously monitored for water level fluctuations. Additional semiannual water level measurements will be taken for area correlation.

Figure 3 shows the locations of monitoring sites for the four types of monitoring to be conducted -- surface water, deep aquifer water, alluvial water and precipitation/evaporation monitoring.

VTN Engineers, Inc. will be under contract to WRSP for the completion of the water resources element.

FIGURE 3

WATER RESOURCES
MONITORING SITES



4.1.1 Surface Water

The surface water monitoring program comprises work efforts of both the USGS Water Resources Division and WRSP.

4.1.1.1 Objectives. The objectives of the surface water monitoring program are to ensure the applicability of the two-year Baseline data to future monitoring periods, and to correlate data collected from the two-year Baseline White River sites with data from the recently installed USGS station (09306395) upstream of Tract Ua/Ub.

4.1.1.2 Methods. Data collection methods are concerned with streamflow, sediment and water quality data.

Streamflow will be measured continuously by the WRSP on the White River downstream from the tract (S-11). The gauging station visitation and maintenance program will be sufficient to ensure as near continuous stream-stage measurement throughout the lease suspension period as practical. The station will be calibrated using current meter measurements as frequently as called for by good hydrological practices, but no less frequently than once per month.

Streamflow will be monitored at an existing station, S-1, on the White River above the tract for 30 days during low (1976) and high flow (1977) in order to verify correlation between S-1 and the new USGS upstream White River Station called "Stateline" (USGS - #09306395). The digital recorder tapes will be removed and processed monthly.

Streamflow will also be measured by WRSP in lower Southam Canyon (S-13). Since flow at this location is only intermittent, the station will be equipped and maintained from about February through October, as dictated

by the past data collected on snowmelt and thundershower seasons. The station will be visited, during the period of operation, at least once each month and following each flow event. The digital recorder tapes will be removed and processed once a month.

Streamflow data will be monitored continuously by the USGS at a new station called Stateline, located 1 mile upstream from S-1 on the White River, at S-3 on the White River near Ignatio, at S-2 on Evacuation Creek near the mouth, and on Evacuation Creek near Dragon. During about April to October, streamflow will be monitored continuously at S-12 on Asphalt Wash near the mouth and S-5 in Hell's Hole Canyon near the mouth.

Suspended sediments will be measured by the WRSP at S-11 and S-13. At S-11 the automatic suspended sediment sampler will be operated continuously. During the high flow period, from about February through October, the automatic sediment sampler will be set to collect four samples a day. From about November through January, the automatic sediment sampler will be set to collect one sample a day. The exact dates and duration of the two sampling periods will depend upon the prevailing hydrological conditions and the judgment of the resident senior WRSP hydrographer. Manual ETR suspended sediment measurements will be performed at intervals necessary to ensure calibration of the automatic sampler, but at least monthly through the year. Samples will be collected during the year's major runoff period so as to correspond to approximately each 0.5' of net river stage rise or fall over the period's rise and fall cycle. Samples will be collected at least monthly over the remainder of the year.

Suspended sediment samples will be collected at S-13 on an opportunistic basis. A single-stage sampler and a crest gauge will be maintained at that location to enhance the opportunistic data collection. Sediment

samples will be analyzed by the WRSP, and daily values of streamflow and suspended sediment will be calculated.

An automatic sediment sampler will be used by the USGS at Stateline (#09306395) and S-2 stations, and two-bottle single-stage samplers may be used at the S-5 and S-12 locations. Suspended sediment data are planned to be collected monthly at S-2 and Stateline and on an opportunistic basis at S-5 and S-12.

Water quality samples will be collected by WRSP at S-11 and S-13. Samples at S-11 will be collected quarterly (January (near low flow), April (near peak flow), July, and October). Water quality samples will be collected from S-13 on an opportunistic basis. Dissolved oxygen, temperature, pH and conductivity will be measured in the field at the time samples are collected. The constituents will be analyzed in accordance with the quarterly and semiannual analytical schedule shown on Table 1. S-13 samples will be analyzed for the semiannual schedule.

Temperature and conductivity will be measured continuously. Both probes will be checked and calibrated regularly, and the digital recorder tapes will be pulled and processed monthly. Temperature and conductivity probes will be maintained at S-13 during the period of its operation. Streamflow, temperature and conductivity will be monitored continuously until November 1, 1976 (or until 30 concurrent days have elapsed) at S-1 to verify correlation with "Stateline". Another 30 day period of concurrent operation will take place during the high flow period in 1977. Correlation coefficients will be calculated among Stateline, S-1 and S-3 within 30 days following receipt of applicable USGS data from S-3 and Stateline. Operation of S-1 will be permanently discontinued if the correlation coefficient from both periods is ≥ 0.9, and if the standard error of estimate is $\leq 10\%$ based on daily values.

Table 1

OIL SHALE PROJECT - WATER QUALITY

SURFACE WATER SCHEDULE - USGS (REVISED DECEMBER 3, 1975

Samples will be collected and analyzed according to the following schedule:

Quarterly (October, January, April, July)

Calcium	Fluoride	Nitrate
Magnesium	Silica	Nitrite
Sodium	Iron	Ammonia
Potassium	Aluminum	Total Kjeldahl Nitrogen
Chloride	Boron	Chemical Oxygen Demand
Sulfate	Lithium	Chlorophyll A
Bicarbonate	Strontium	Chlorophyll B
Carbonate	Manganese	Color
Alkalinity	Phosphate	Turbidity
Hardness	Total Phosphorus	Dissolved Solids

Semiannually (October, Apirl)

Arsenic	Selenium	Lead
Cadmium	Vanadium	*Detergents
Chromium	Zinc	Organic Carbon (Dissolved)
Copper	Barium	*Pesticides
Mercury	Sulfide	Phenols
Molybdenum	Bromide	**Gross Alpha & Beta

Whenever a station is visited, field measurements will be made of pH, temperature, conductivity and dissolved oxygen.

* Not included in WRSP Program.

** If gross alpha activity is measured at greater than 4 picocuries/liter, then analysis for radium 226 and for natural uranium will be done. If gross beta activity is greater than 100 picocuries/liter, then analysis for Sr^{90} and Ce^{137} will be done.

Recorder tapes will be pulled and processed monthly.

Water quality samples will be collected by the USGS and analyzed quarterly at S-2, S-3 and Stateline. The samples will be analyzed for the constituents listed on Table 1. This list is currently being revised by the USGS.

It is possible that the USGS may elect to modify their program from that described above. In that event, WRSP would continue the operation of "Stateline" and S-2 at the level of effort described above.

4.1.1.3 Data Analysis and Reports. WRSP will reduce the data produced at the sites operated by WRSP. The USGS data will be acquired and integrated into the data review program as it becomes available.

Two reports will be provided to the AOSS (See Section 6.0 - Suspension Period Reports). The first report will cover the period October 1, 1976 - April 30, 1977. This report will review the objectives and methods used for data acquisition. It will include all the data collected during this period that is reasonably available. A brief comparison will be made between the data from corresponding Interim and Baseline periods.

The final report will cover the period October 1, 1976 - October 31, 1977. All the data from the second period will be presented. The full October 1, 1976 - October 31, 1977 period will be compared in detail to the Baseline period. Conclusions concerning trends, anomalies, etc. will be presented. In addition, the following hypotheses will be tested:

- There are no significant differences in chemical or physical composition of the surface water between comparable data from the two-year Baseline and Interim periods.
- There are no significant differences in chemical or physical composition of the surface water between stations "Stateline," S-1, S-3, S-4 and S-11.

4.1.1.4 Rationale. The use of "Stateline" and S-11 will provide data from upstream and downstream of Tract Ua/Ub. Stations on Evacuation Creek (S-2) and Southam Canyon (S-13) will provide data from the significant drainage channels on the tract.

Data from these sites will adequately continue collection of key data that will allow for the use of Baseline data during future monitoring periods.

The operation of S-1 for 30 days during low and high flow, in conjunction with past data, should allow for the transfer of S-1 Baseline data record to "Stateline". Stateline can then be used as the upstream station of record for Tract Ua/Ub.

4.1.2 Deep Aquifer Water

The aquifer monitoring program, like the surface water program, is based on a combination of WRSP and USGS efforts.

4.1.2.1 Objectives. The objectives of this monitoring element are to extend water level data so as to provide continuity between the Baseline work and future monitoring periods, and to investigate long-term water level trends.

4.1.2.2 Methods. Water levels will be continuously monitored by the USGS at P-1, P-2 Upper and P-2 Lower, and by the WRSP at P-3. A float and time activated digital punch recorder will record the level every 15 minutes at P-1, P-2 Upper and P-2 Lower. Water level at P-3 will be recorded every hour. For quality assurance, WRSP will manually check the water level at P-3 once per month.

Manual water level readings will be taken by WRSP at G-8, G-8A, G-5, G-10, G-11, G-15, G-21 and P-4 twice per year during periods which correspond to maximum and minimum water levels as found during the Baseline period.

4.1.2.3 Data Analysis and Reports. WRSP will recover and reduce the data from WRSP collection efforts discussed above. USGS data will be acquired and incorporated into the data base as it becomes available.

Two reports will be provided AOSS during the suspension period (See Section 6.0). The deep aquifer element results will be handled in the same manner as the surface water element described in Section 4.1.1.3, except that the following hypothesis will be tested with aquifer data in the final report:

- There are no significant differences in water levels at corresponding sites between the two-year Baseline and Interim monitoring periods.

4.1.2.4 Rationale. The wells to be used during the Interim program are from the same group used during Baseline monitoring. These wells provide good coverage of the tract.

Twice yearly water levels will support the continuous measurements and provide adequate indication of trends over the year at these sites.

Additional water quality data will not be required on ground water due to the slow movement of water over time as evidenced by the data collected to date.

4.1.3 Alluvial Water

The USGS Water Resources Division plans to incorporate several wells into their own program. The program discussed below, therefore,

will almost entirely be carried out by the USGS, and represents the program as initiated October 1, 1976, and with modifications effective in January 1977.

4.1.3.1 Objectives. The objectives of the program described in this section are to extend the data base in regard to alluvial well water levels and water quality, and to begin identifying long-term trends of these two parameters.

4.1.3.2 Methods. Monthly water level, temperature and conductivity measurements will be made through December 1976 at eight locations in five drainage areas:

1. White River (AG-1 Upper/Lower and AG-3 Upper/Lower)
2. Hell's Hole Canyon (U/L near mouth)
3. Evacuation Creek (AG-8 U/L, near Park Canyon U/L and above Missouri Creek U/L)
4. Southam Canyon (AG-6 U/L)
5. Asphalt Wash (AG-4 U/L)

Water quality samples will be withdrawn quarterly through December 1976 and analyzed pursuant to the schedule on Table 2. Additional water quality samples will be withdrawn from AG-1, AG-3, AG-6 and AG-8 if the conductivity measurement is 20% higher than the maximum recorded value, or 20% lower than the minimum recorded value of record for a corresponding past period. These additional samples will also be analyzed pursuant to the schedule on Table 2.

The program frequency of sampling will be modified in January 1977. The locations will remain the same. Effective that month, conductivity,

Table 2

OIL SHALE PROJECT - WATER QUALITY

GROUND WATER SCHEDULE - USGS SITES (REVISED DECEMBER 3, 1975)

Sodium	Iodide	Strontium
Aluminum	Lithium	Vanadium
Arsenic	Magnesium	Zinc
Boron	Manganese	Dissolved Solids
Barium	Molybdenum	Bicarbonate
Bromide	Nitrate & Nitrite	Carbonate
Calcium	Ammonia	Alkalinity
Cadmium	Total Kjeldahl Nitrogen	Hardness
Chloride	Phosphate	Organic Carbon (Dissolved)
Chromium	Total Phosphorus	*Gross Alpha & Beta
Copper	Lead	Radium 226
Fluoride	Sulfate	**Temperature
Iron	Sulfide	**Conductivity
Mercury	Selenium	**pH
Potassium	Silica	

* If gross alpha activity is measured at greater than 4 picocuries/liter, then analysis for radium 226 and for natural uranium will be done. If gross beta activity is greater than 100 picocuries/liter, then analysis for Sr^{90} and Ce^{137} will be done.

** Field Measurements

temperature and water level will be measured quarterly. A water quality sample will be taken once during high flow period of 1977 either by USGS or WRSP at AG-1, AG-3, AG-6 and AG-8. Monthly water level, conductivity and temperature measurements will resume at AG-1 and AG-6 during snowmelt and thunderstorm seasons (approximately February-October).

The USGS program is subject to change at the discretion of the USGS Water Resources Division. WRSP will review any changes planned by the USGS. WRSP will assume operation of sites AG-1, AG-3, AG-6 and AG-8 if the changes call for deletion of these sites.

4.1.3.3 Data Analysis and Reports. Data will be obtained from the USGS as it becomes available.

The alluvial ground water program will be discussed in the two reports described in Section 6.0 (Suspension Period Reports). The first report will cover the period October 1, 1976 through April 30, 1977. The objectives and methods used will be reviewed, and all the data for the period will be presented (subject to availability at the time of report preparation). Data will be compared to Baseline periods.

The final report will cover the period October 1, 1976 - October 31, 1977. All the data from the second period will be presented. The full October 1, 1976 - October 31, 1977 period will be compared in detail to the Baseline period. Conclusions concerning trends, anomalies, etc. will be presented. In addition, the following hypotheses will be tested:

- There are no significant differences in water level and chemical composition between comparable data from the two-year Baseline and Interim periods.
- There are no significant differences in water level and chemical composition between comparable data from the two White River alluvial well sites (AG-1 and AG-3).
- There are no significant differences in chemical composition between upper and lower well points at any specific location.

4.1.3.4 Rationale. The wells involved in the USGS program include the wells of interest to WRSP monitored during the Baseline program. The monthly conductivity, temperature and water level effort will have collected a full 12 months of monthly data from the wells of interest to WRSP by January 1977. Based on the past data, quarterly conductivity, temperature, and water level monitoring, plus monthly monitoring of AG-1 and AG-6 during snowmelt and thunderstorm seasons will be adequate to meet the alluvial well program objectives. Water quality will be monitored adequately since at least quarterly conductivity measurements, which indicate the state of water quality, will be made to supplement the analyses of the well water for specific elements.

4.1.4 Precipitation/Evaporation

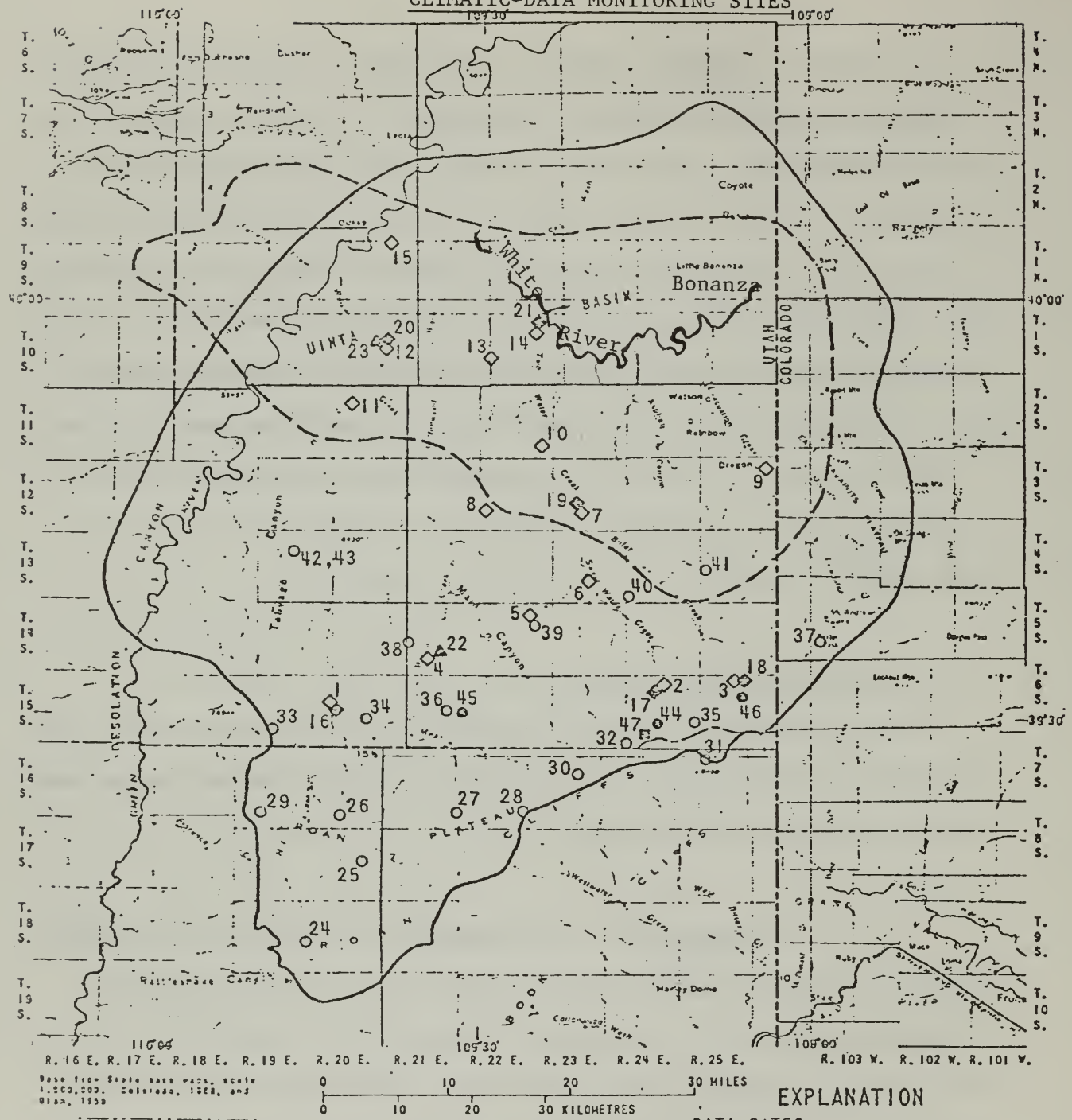
The following program will be implemented during January 1977. The Interim Monitoring Program will be modified from the Baseline program insofar as fewer sites will be used.

4.1.4.1 Objectives. The objectives of the precipitation/evaporation program are to augment the USGS regional data collection network (See Figure 4), provide site specific information on precipitation and evaporation at the plant site and processed shale disposal area, and to place the Interim period in historic perspective.

4.1.4.2 Methods. Precipitation will be measured by automatic gauges at three locations. The plant site gauge (AR-13) will be operated year round. The two Southam Canyon sites (AR-2 and AR-9) will be operated generally April through October.

Figure 4

CLIMATIC-DATA MONITORING SITES


White River
Bonanza
BASIN
UINTA
UTAH
COLORADO
DESOLATION CANYON
PLATEAU
R. 16 E. R. 17 E. R. 18 E. R. 19 E. R. 20 E. R. 21 E. R. 22 E. R. 23 E. R. 24 E. R. 25 E.
R. 103 W. R. 102 W. R. 101 W.
0 10 20 30 MILES
0 10 20 30 KILOMETRES

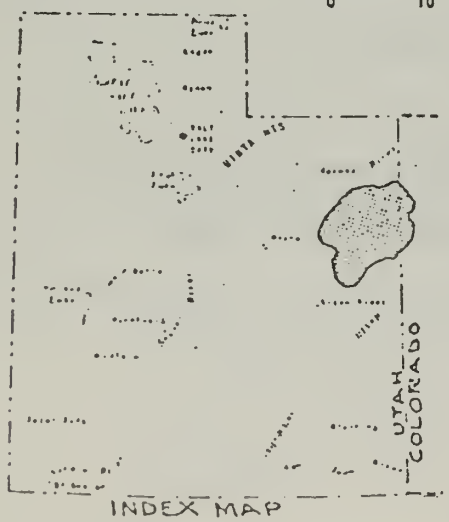
EXPLANATION

DATA SITES

- ◇10 Precipitation, storage gage
- ◈18 Precipitation, intensity gage
- △22 Temperature gage
- ○26 Snow-depth gage
- ●44 Snow course
- ▫47 Evaporation gage

Number by symbol is shown in table 4

- Boundary of oil shale that yields 15 gallons (57 litres) or more of oil per ton and is at least 100 feet (30 metres) thick
- Area of hydrologic investigations



INDEX MAP

Evaporation will be measured in Southam Canyon (EVP-2) and at the proposed plant site (EVP-13) during the determined evaporation season.

4.1.4.3 Data Analysis and Reports. The data will be collected and reduced by WRSP. USGS data will be included as it becomes available and is pertinent to the report discussion. Results from the precipitation/evaporation program will be reported in the two reports discussed in Section 6.0 (Suspension Period Reports). The first report will include the data from the period January 16, 1977 - April 30, 1977. Objectives and methods for data collection will be reviewed. Interim period data will be compared to corresponding Baseline period data.

Data from the full January 16, 1977 - October 31, 1977 period will be included in the final report. The Interim period will be compared in detail to the Baseline period. In addition, the following hypotheses will be tested:

- There are no significant differences in the precipitation/evaporation measurements between the Baseline and Interim periods.
- The existing USGS precipitation network is adequate to predict precipitation levels on Tract Ua/Ub.

3.1.4.4 Rationale. Precipitation data is important in regard to water retention structures and revegetation. As such, measurements are important to WRSP primarily in Southam Canyon and near the proposed plant site. Both areas will have retention structures constructed in the respective drainage channels, and Southam Canyon is the proposed processed shale disposal site.

The three precipitation sites were selected, therefore, to cover the plant site and Southam Canyon.

4.2 AIR RESOURCES

The two-year Environmental Baseline Monitoring Program in regard to air resources will be completed by January 15, 1977. This program was a very exhaustive effort in regard to the air quality and meteorology incidental to Tract Ua/Ub. For one year eight air quality monitoring stations were operated. During 1976 four air quality monitoring stations have been operated.

The Interim air resources monitoring program element has been designed to be a systematic step between the Baseline Monitoring Program being completed and the Development Monitoring Program described in the Detailed Development Plan. The Interim Monitoring Program will continue collection of pertinent air quality and meteorological information.

Figure 5 shows the locations of the Interim monitoring sites. AeroVironment Inc. will perform the air monitoring work under contract to WRSP.

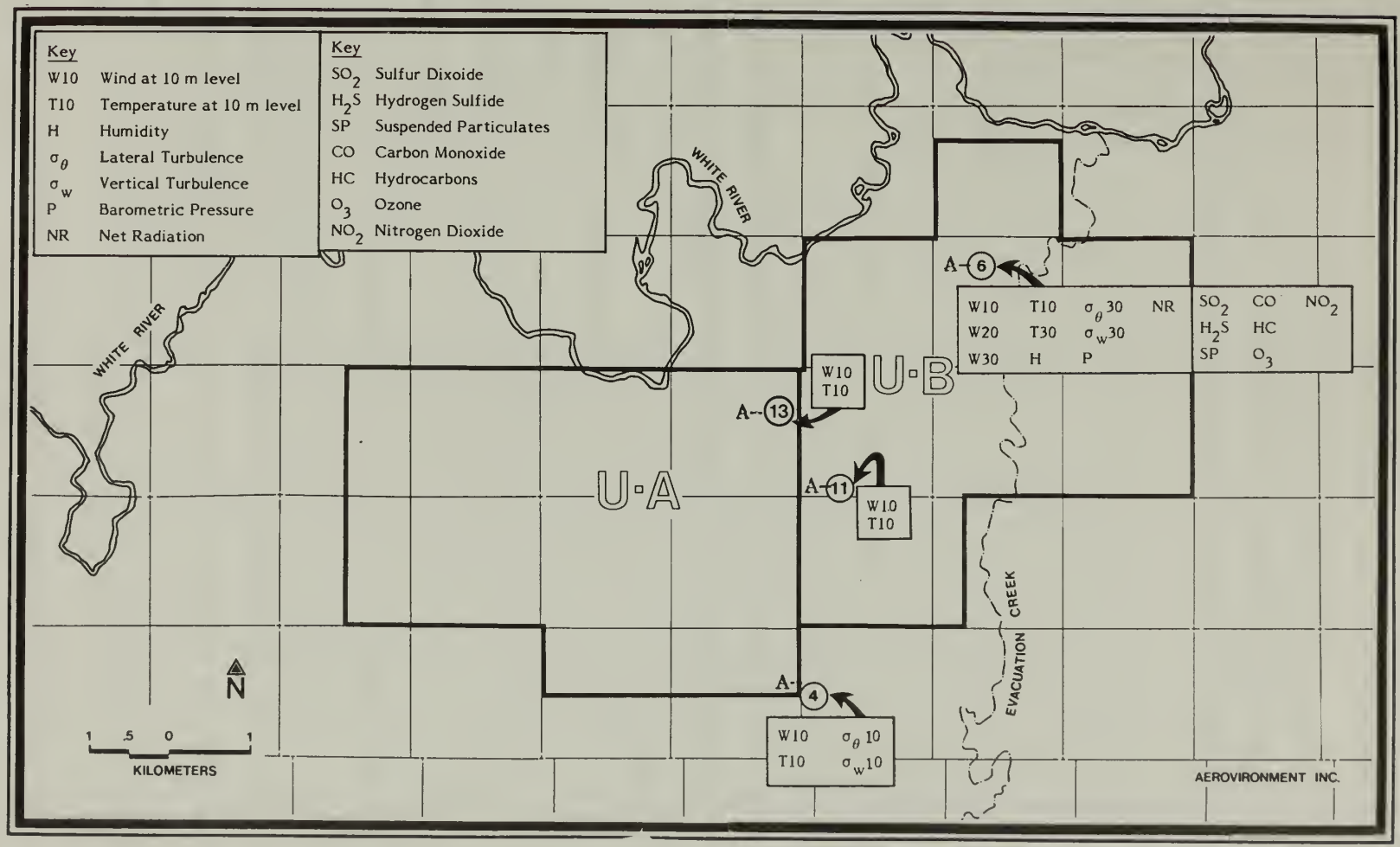
4.2.1 Air Quality

The air quality monitoring program will be initiated January 16, 1977. Monitoring equipment and selected locations will be identical to those used during Baseline monitoring.

4.2.1.1 Objectives. The prime objective of the program is to determine if the occasional high levels of ozone and non-methane hydrocarbons noted during the Baseline period recur during the Lease Suspension Period. Another objective is to maintain continuity of data on other air quality parameters.

Figure 5

LOCATIONS OF METEOROLOGICAL & AIR QUALITY MEASUREMENT STATIONS ON TRACTS U-a and U-b



4.2.1.2 Methods. Station A-6 (See Figure 5) will be operated during the suspension period. Table 3 summarizes the data to be collected at this location. Table 4 lists the instruments to be used. All parameters, except suspended particulates, will be monitored continuously. Data will be recorded on digital punch tapes every 6 minutes, and strip charts every 2 minutes.

Station A-2 will be maintained on a standby basis. A-2 has the same instrumentation as A-6 and would be put into service if A-6 becomes inoperable.

Suspended particulates will be measured over a 24 hour period at A-6 every sixth day. This schedule is the same as used in the Baseline Monitoring Program and is considered sufficient for continued characterization of the randomly produced background particulate material levels. The specific measurement techniques to be used are the same as those used during the Baseline program, which have been described extensively in previous reports on that program.

Quality assurance will be provided through four techniques. First, all of the instruments to be used during this year will be recalibrated near the beginning of this period (within 90 days before or after January 15, 1977). Second, the air quality equipment will be recalibrated (dynamic multiple point) monthly and, third, the equipment will receive span and zero checks every three or four days. This schedule of calibration is more frequent than that for the Baseline program. It reflects the greater reliability demanded of a single air monitoring station. Fourth, in addition to the normal internal quality assurance procedures maintained by AeroVironment, the White River Shale Project is participating voluntarily in an air pollution measurement quality assurance program implemented by the Environmental Protection Agency.

Table 3

PARAMETERS TO BE MONITORED DURING THE LEASE SUSPENSION PERIOD

Parameter	Station			
	A4	A6	A11	A13
Air Quality				
Total Sulfur		X		
SO_2		X		
H_2S		X		
Total Hydrocarbons		X		
CH_4		X		
CO		X		
NO		X		
NO_x		X		
NO_2		X		
O_3		X		
Suspended Particulates		X		
Meteorology				
WS/WD - 10 m	X	X	X	X
WS/WD - 20 m		X		
WS/WD - 30 m		X		
T - 10 m	X	X	X	X
T - 10-30 m		X		
σ_θ - 10 m	X			
σ_θ - 30 m		X		
σ_w - 10 m	X			
σ_w - 30 m		X		
Solar Radiation		X		
Dew Point		X		
Relative Humidity		X		
Barometric Pressure		X		

Table 4

AIR RESOURCES MONITORING EQUIPMENT

Wind Speed and Direction	MRI Model 1022 Anemometer	A-6 (10 and 30M) A-4 (10M)
Wind Speed, Direction, and Temperature	MRI Model 1071 Mechanical Weather Station	A-11 (10M) A-13 (10M)
Wind Variance	MRI Model 1022/R.M. Young and AeroVironment Sigma Meter	A-6 (30M) A-4 (10M)
Temperature and Lapse Rate	MRI Thermistors w/R.M. Young Shield	A-6 (10 and 30M) A-4 (10M)
Dew Point	EG&G Model 880 Hygrometer	A-6
Suspended Particulates	General Metals Model 5000 HiVol w/Constant Flow Control	A-6
Sulfur Dioxide	Tracor 270 HA Sulfur Analyzer-Gas Chromatography	A-6
Nitrogen Oxides	Monitor Labs Model 8440 NO_X Analyzer Chemiluminescence	A-6
Hydrocarbons	Beckman 6800 Gas Chromatograph, Flame Ionization	A-6
Carbon Monoxide	Beckman, 6800 Gas Chromatograph, Flame Ionization	A-6
Oxidants	Monitor Labs 8410, Ozone Analyzer, Chemiluminescence	A-6

4.2.1.3 Data Analysis and Reports. Data for all parameters, except particulates, will be reduced to one-hour averages. Particulates will be expressed as the 24 hour average for a specific day.

All data will be reviewed for consistency, and questionable data deleted from the data base. Details of data handling will be the same as used during the Baseline period. The data submission format will be the same as in the Baseline period and will consist of finalized computer printouts.

The air quality monitoring work will be reviewed in the two reports discussed in Section 6.0 (Suspension Period Reports). The first report will cover the period January 16, 1977 - April 30, 1977. All data collected during this period will be included in this first report. Objectives and methods will be discussed in the report, as well as a comparison of the specific Interim period data to the Baseline period data.

The final report will cover the entire January 16, 1977 to October 31, 1977 period. All data not presented in the first report will accompany the final report. A detailed comparison of Baseline and Interim period data will be presented. Pertinent observations and conclusions will be made.

In addition, the final report will test the following hypotheses:

- There are no significant differences in air quality between the Interim and two-year Baseline periods.
- Ozone and non-methane hydrocarbons are, within monitoring technique and instrument accuracy, occasionally at or above existing Federal National Ambient Air Quality Standards.

4.2.1.4 Rationale. Upon the completion of the two years of comprehensive Baseline data collection and monitoring required by the environmental stipulations of the relevant leases, the objective of the monitoring during the period of lease suspension will be to provide continuity to the

data collection effort and to provide further support to the findings of the Baseline monitoring program. Of particular interest in this regard are the levels of ozone and non-methane hydrocarbons. Levels of both materials were found to occasionally exceed National Ambient Air Quality Standards.

The activities during the suspension period, therefore, will no longer be concerned with the acquisition of new data to define conditions for which no prior data was available. This change in perspective influences the nature and magnitude of the measurement, analysis, and reporting activities which will take place during the year.

The air quality measurements made during the Baseline program have, for the most part, shown considerable uniformity from one site to the next. Because of this, one monitoring station will suffice to define air pollutant conditions on both of the tracts. Station A-6 has been selected because its exposure to the area-wide ambient conditions is less affected by localized features than any other station. In fact, it was originally designated two years ago as the most representative station on the two tracts for exactly the same reason. In addition to this primary reason, a secondary factor for this choice is the desirability of maintaining data continuity at one location rather than making arbitrary station location changes. This mandates the choice of Station A-6 since neither of the other two comprehensive air quality stations (A-2 and A-3) have been in full operation since the spring of 1976.

2.2 Meteorology

Meteorological measurements as part of the two-year Environmental Baseline Monitoring Program will be completed January 15, 1977. The

program discussed in this section will be implemented January 16, 1977. Monitoring equipment and selected specific sites will be identical to those used during the Baseline period.

4.2.2.1 Objectives. The objectives of continuing meteorological data collection in the Interim Monitoring Program are to extend the meteorological data base, determine trends, extend data collection at A-13 to a full year, and to provide data verification of Baseline data for use in future air pollutant dispersion modeling work.

4.2.2.2 Methods. Figure 5 shows the locations of monitoring sites, and Table 3 summarizes the data to be collected at each station.

These sites are A-4, A-6, A-11 and A-13. The meteorological equipment is shown on Table 4 and is the same as used during the Baseline. Meteorological data will be collected continuously and recorded on digital punch tapes every 6 minutes. Strip charts will also be used at A-4 and A-6 for a backup record.

Although upper air measurements, by rawinsonde or acoustic sounding, are not included in this year's activities, nor have any such measurements been made since their suspension was approved by the Area Oil Shale Supervisor early in 1976, a related program will be collecting upper air data during much of the year. AeroVironment Inc. is performing balloon soundings of upper air structure (winds and temperature) twice daily on alternate days from October 1976 through September 1977. This work is being funded primarily through an Environmental Protection Agency contract. The White River Shale Project is providing additional financial and logistical support for this activity.

4.2.2.3 Data Analysis and Reports. Data will be reduced to hourly averages from the punch tapes or strip charts.

All data will be reviewed for consistency, and questionable data deleted from the data base. The data submission format will be the same as used during the Baseline period and will consist of finalized computer printouts.

The meteorological data collection work will be reviewed in the two reports discussed in Section 6.0 (Suspension Period Reports). Both reports will cover meteorology in a similar manner to air quality, except the following hypotheses will be tested in the final report in place of those shown in Section 3.2.1.3:

- There are no significant differences in meteorological parameters between the Interim and Baseline periods.
- The Interim period was a "typical" year based on the correlative record to date.

The specific statistical tests to be used will be discussed in the progress report. They will be based on the results of the data analyses work completed in preparing the Final Environmental Baseline Monitoring Report.

4.2.2.4 Rationale. The spatial variability of microscale meteorological conditions on the tract is considerably greater than the air quality variation. Operation of more than one meteorological station is, therfore, advisable. The Detailed Development Plan has defined some of the details of mine and plant location and operation, so the area of greatest interest for microscale meteorological monitoring is in the vicinity of these facilities. The meteorological equipment at Stations A-4, A-11 and A-13 will be operated along with the comprehensive meteorological facility at

Station A-6 to provide coverage of Southam Canyon, plant site and the nearby areas.

Since Station A-13 commenced operation in the spring of 1976, its continued operation will provide the first data on plant site area conditions throughout all seasons of the year.

Visibility measurements, either by photography or by integrating nephelometer will not be made during the suspension period; the existing measurement base adequately defines conditions, and there are no expected factors which will measurably alter these conditions during the lease suspension year. Similarly, no noise measurements will be undertaken for the same reasons.

4.3 BIOLOGICAL RESOURCES

Biological resources monitoring for the two-year Environmental Baseline Monitoring Program will be completed by January of 1977. Most of the Interim Monitoring Program described in this section will be implemented in January of 1977.

Monitoring work will involve vegetation and terrestrial vertebrates. Data from a USGS Water Resources Division aquatic biology monitoring program will be incorporated into the data base. Data from ongoing Utah Division of Wildlife Resources and Bureau of Land Management programs will also be reviewed and incorporated as applicable.

The monitoring work will be similar to the techniques used in the Baseline program. BioWest and the Utah Division of Wildlife Resources will do the terrestrial vertebrates monitoring, and Dr. C. M. McKell will do the vegetation monitoring.

Figure 6 shows the monitoring sites for vegetation and animal monitoring activities (except large mammal sampling quadrats).

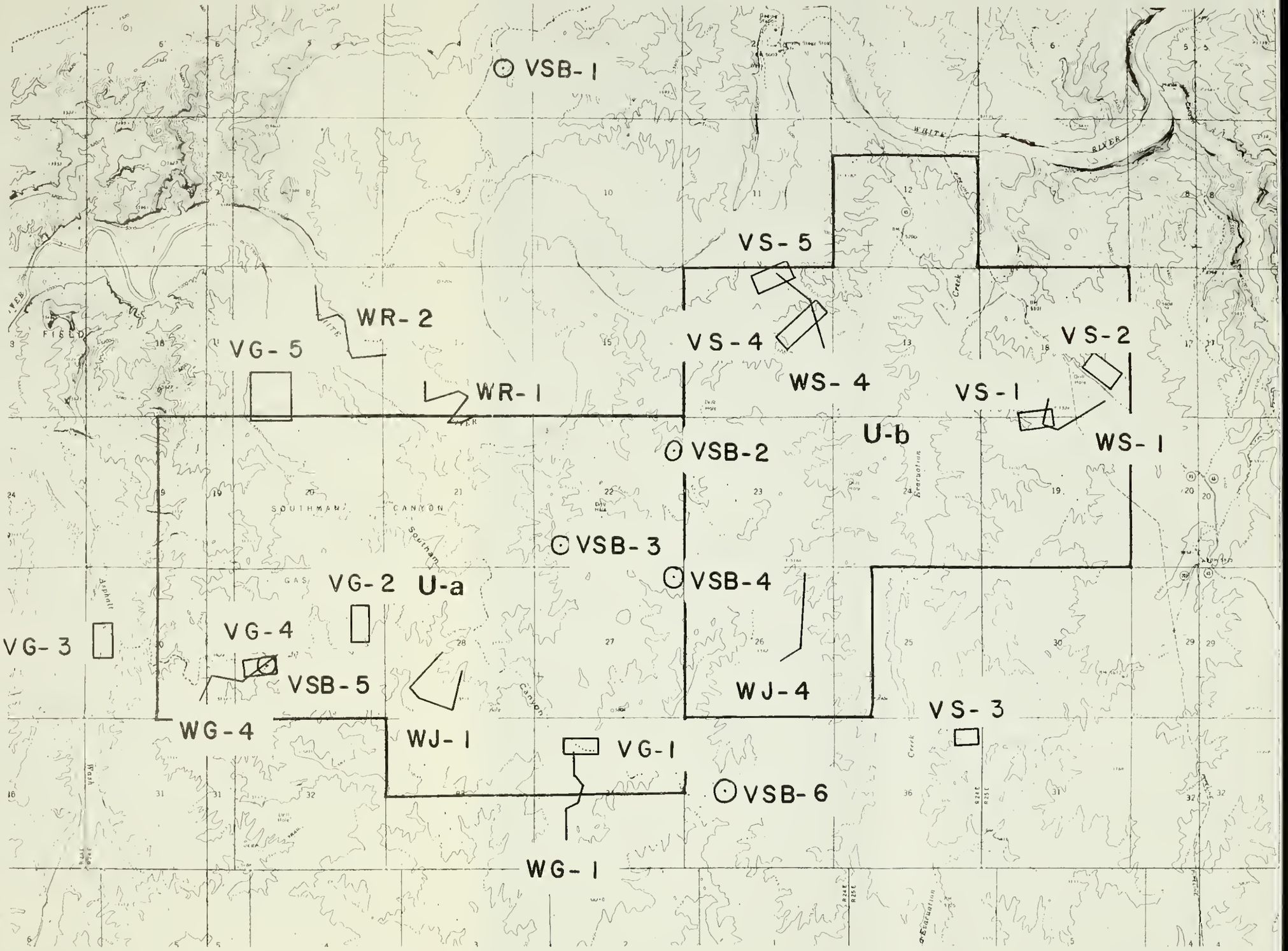
4.3.1 Vegetation

The following describes the monitoring to be done on the vegetation sites shown in Figure 6. Work in the course of the Revegetation Study Program will supplement this monitoring.

4.3.1.1 Objectives. The major objectives are to maintain continuity of key parameter data collection, determine trends, develop supportive vegetation data for animal monitoring results, and to explore "control" versus "treatment" system of monitoring oil shale development impacts. The last objective holds the promise of factoring out natural cyclic trends while determining true net impacts of development operations.

FIGURE 6

VEGETATION/VERTEBRATES
MONITORING SITES



LEGEND

- □ = VEGETATION - GREASEWOOD, JUNIPER, SHADSCALE
- ⌇ = WILDLIFE
- ⊙ = VEGETATION - SAGEBRUSH

4.3.1.2 Methods. During the period of lease suspension the task of monitoring vegetation will consist of the following:

A. Measurement of productivity of annual plant species.

B. Measurement of leader growth of big sagebrush, a dominant shrub on Tract Ua/Ub.

C. Measurement of percent of stems browsed on shrubs measured in B.

D. Perform visual surveys of general nature in regard to vegetation conditions, including

- seed production
- seedling establishment
- animal utilization
- any unusual buildup of insects or plant disease or early seasonal dormancy.

At the peak of annual growth in the spring (June) annual species will be clipped from approximately 200 .5 m^2 plots in areas previously sampled during the Baseline study located in the sagebrush/greasewood vegetation type and the shadscale/sagebrush type. Sampling would be done in the same manner as in the Baseline inventory. Three areas in Section 22 will be included in the sampling for productivity of annual plants. These areas will correspond to the sagebrush stem growth transects. Sampling of the juniper type may be necessary but will depend upon the favorability of the growing season. In 1976 annual plant species productivity in the juniper type was extremely low; thus, an ocular estimate would be adequate under such circumstances.

In the fall (September-October) current year's stem growth of big sagebrush will be measured in a paired-plot arrangement on an adequate number of sagebrush plants along three transects in the zone of influence of the proposed industrial site (in Section 22) and on three transects in areas surrounding that site. This will allow a comparison of stem growth in and around the proposed industrial site and in surrounding areas.

During the time of productivity sampling in the spring and the measurement of stem growth in the fall, an ocular reconnaisance of vegetation conditions on the tracts will be made. Reproduction, plant growth and vigor, and any excess animal utilization will be noted. Quantitative data will be obtained to validate any visual observations as required. Observations of vegetation condition may also be conducted as an ongoing activity during revegetation study.

4.3.1.3 Data Analysis and Reports. Data will be summarized and subjected to a statistical analysis utilizing a t-test procedure[1/]. Productivity data and plant measurements from plots in the expected impact area and those from the non-impact area will be compared. Obviously, no difference would be expected in 1977 but a procedure would thus be established and evaluated for future use.

The number of plots or plants required for sampling within 20 percent of the mean at a 90 percent probability level will be determined, and will probably be less than 200. Data from the 1975 and 1976 Baseline inventory will serve as a guide to the actual number of plots or plants necessary in the 1977 inventory.

A comparison of results obtained in 1977 will be made with data provided in the 1975 and 1976 Baseline reports.

The vegetation work will be reported in the final report. This report will cover the period January 16, 1977 - October 31, 1977. This report will present the data collected during the Interim monitoring

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1/ Snedecor, G. W. 1967. Statistical Methods. 6th Edition, Iowa State College Press. Ames, Iowa.

period, review the program objectives and methods, and compare Interim period data with Baseline data. Observations and conclusions will be discussed.

In addition, the following hypotheses will be tested:

- There are no significant differences in comparative vegetation data between the Interim and Baseline periods.
- The annual productivity of Tract Ua/Ub is "poor" (low).

4.3.1.4 Rationale. Certain vegetation parameters measured in the Baseline inventory are subject to wide annual variation. Productivity is one such major variable. Another variable is visual condition which may be caused by non-plant factors. These two parameters are subject to change and should be kept under observation. An additional year's data on productivity will provide a broader base of information from which to make comparisons after the initiation of development. By setting up sampling procedures in a manner that include the area of industrial activity along with similar areas that are not expected to be impacted, the extended vegetation monitoring program can lay the groundwork for useful comparisons in the future.

The harvest yields of annual species in the spring and of shrub stem growth in the fall would provide an assessment of productivity and growth as influenced by current weather and subsequently by any impacts of development. At present there are no productivity plots in the immediate area of expected impact. Sampling of the understory in the sagebrush sampling areas in Section 22 would be established in order to provide a comparison with areas some distance from the projected industrial site. By starting such comparisons in 1977 statistical variability and adequate number of plots and stem measurements can be determined.

An assessment of livestock/wildlife browsing pressure would be provided by the count of sagebrush stems browsed. Such counts would have to continue for more than one year to provide a basis of comparison, especially to be useful in evaluating any impacts of development.

4.3.2 Terrestrial Biology

All portions of the required two year Environmental Baseline Monitoring Program will be completed by January 15, 1977. Most of the work was completed by October 1976.

The Interim Monitoring Program described in this section will concentrate on birds and mammals. No further work is required during the suspension period on reptiles, amphibians or aquatic biology.

The USGS, however, is conducting an aquatic biology survey near the tract. The data from this program, and applicable programs conducted by the Utah Division of Wildlife Resources (DWR) and/or Bureau of Land Management, will be incorporated into the WRSP data base.

The Utah Division of Wildlife Resources will be participating directly in the large mammal survey work. DWR authorization for conducting the other parts of the program will be required prior to initiation by WRSP.

Figure 6 shows the location of sampling sites.

4.3.2.1 Objectives. The major objectives of the program is to extend the data base on selected birds and mammals so as to investigate population trends noted during the Baseline period. Other objectives are to evaluate control-treatment monitoring techniques which would allow for distinguishing directly between natural cyclic changes and changes attributable to oil shale development activities.

4.3.2.2 Methods. The program will gather data in the following areas:

1. Density estimates for species, genera, family, order and vertebrate class;

2. Identification of species, genus, etc.;

3. Spatial distribution of species, genus, etc. throughout the tract; and,

4. Seasonal activity of species, genus, etc.

The test design for collection of appropriate data is based upon four sampling techniques. Flushing transects will be employed in February, June and August to monitor bird and diurnal mammal populations. Small (5 x 5) live-trap grids will be used in February, June and August, and large (12 x 12) live-trap grids once in August to monitor small nocturnal rodents. A large mammal aerial survey will be made in December to provide density and distributional information on mule deer, other large mammals and raptors. The four techniques are described according to sampling location (defining distribution), frequency (defining seasonal activity), and intensity (defining density).

Flushing transects will be used to monitor bird and diurnal mammal populations at eight locations. There will be eight 1 km flushing transects on the tract and within the one mile boundary area. These transects are located in the following vegetation associations:

1. Juniper vegetation in Southam Canyon (WJ-1);

2. Juniper vegetation east of Southam Canyon (a new location) (WJ-4);

3. Greasewood vegetation in Southam Canyon (WG-1);

4. Greasewood vegetation west of Southam Canyon (a new location) (WG-4);

5. Shadscale vegetation near the eastern border of Tract Ub (WS-1);

6. Shadscale vegetation south of Ignatio Stage Stop (a new location) (WS-4);

7. Riparian vegetation in White River bottomland (WR-1);

8. Riparian vegetation, off-site; in White River bottomland (WR-2).

The specific transect locations (Figure 6) are primarily designed to allow for adequate coverage of Tract Ua/Ub in extending the Baseline data base. Secondarily, some locations can be designated as control-treatment sited during shale processing. Two transects in South Canyon (WG-1 and WJ-1), the area for spent shale disposal, will monitor changes within the treatment area. Two other transects to the east (WJ-4) and the west (WG-4) of Southam Canyon will be control sites. No activities are planned in the latter areas throughout Tract Ua/Ub development. WS-1 can be considered a control site in the shadscale vegetation since it is some distance from any site of planned activity. WS-4 near Ignatio Stage Stop can be used as a site to monitor changes due to vehicular traffic during construction and processing.

Control treatment designations cannot be given to the riparian transects. The river's importance is due to the refuge effects for vertebrates throughout the tract. Paired transects allow for comparisons within and among vegetation types (the same applies to the small live-trapping grids).

Data recorded within a transect's length are: species identification; flushing distance perpendicular to the transect line; number observed; age and sex, where possible; and activity (e.g., feeding, flying). Morning transects are walked for birds, evening transects for mammals.

The flushing transects will be walked during three sampling periods; February, June and August. Eight locations will be sampled during each

sample period. Each location will be sampled for five consecutive days. Four vegetation types are represented by the eight locations. The distribution of sampling effort is shown in Table 5.

Small live-trap grids will be used to monitor small nocturnal rodent populations. The grids are set to straddle each of the eight flushing transects. Each grid consists of 25 Sherman live-traps placed 15 m apart covering a 0.36 hectare area. Traps will be opened and baited with rolled oats each evening then checked every morning. Each animal captured will be identified as to species, age, sex, and sexual and physical condition. Each animal will then be weighed and individually marked prior to release.

Live-trapping with samll (5 x 5) grids will be conducted during three sample periods; February, June and August. Trap grids will be set out and operated for five consecutive trap nights during each sample period (See Table 5). All four vegetation types will be sampled since small grids straddle the flushing transects.

Large live-trap grids will be employed in August to monitor small nocturnal rodents. A 12 x 12 live-trap grid covering 2.7 hectares will be set out in each of the four vegetation associations occuring on the lease tract; shadscale (WS-1), greasewood (WG-1), juniper (WJ-1) and riparian (WR-1). Data collected for each capture will be the same as data recorded for rodents captured in the small live-trap grids. Large live-trap grids will be used in August. A 12 x 12 live-trap grid is operated for five consecutive nights in each of the four major vegetation types (i.e., Juniper, Greasewood, Shadscale and Riparian).

A large mammal aerial survey will be conducted for two days in December. It will be used to estimate distributions and densities of mule

Table 5

DISTRIBUTION OF FLUSHING TRANSECT EFFORT BY VEGETATION TYPE

Vegetation Type	No. of Transects	No. of Days	Transect Days
Juniper	2	5	10
Greasewood	2	5	10
Riparian	2	5	10
Shadscale	2	5	10

deer and other large mammal populations on the tract. The survey will be conducted by two observers from a helicopter. Each of the four major vegetation types will be sampled several times in proportion to expected deer densities and expected observer error.

A stratified random quadrat design will be employed similar to that of Siniff and Skogg (1964). The study area is stratified according to vegetation types. Sampling effort is allocated optimally so that the strata are sampled disproportionally. Strata in which high deer densities are expected and strata where deer counting are difficult are sampled more intensively than others.

This program may be revised based on suggestions by the Utah Division of Wildlife Resources (DWR), and subject to the approval of the AOSS. The DWR will be directly involved in carrying out this program.

In addition to the four quantitative sampling techniques proposed, biologists working on the tract maintain field notebooks of pertinent observations. These will include sitings of herptiles, raptors, bats, and any rare and endangered species.

Species identification and distribution follow Bailey and Niedrach (1965), Behle and Perry (1975), Peterson (1961) and Robbins et al. (1966) for birds; Stebbins (1966) for herptiles; and Armstrong (1972), Barbour and Davis (1969), Burt and Grossenheider (1964), Durrant (1952), and Hall and Kelson (1959) for mammals. Additional information concerning game species will be collected by the Utah Division of Wildlife Resources. Data on the aquatic biology of the White River will be collected by the U. S. Geological Survey (See Section 4.3.3).

4.3.2.3 Data Analysis and Reports. Analysis of the data will be handled in the following manner:

1. Flushing Transects: Data is grouped by vegetation types to produce density estimates. Density estimates are made by the perpendicular distance method described by Kelker (1945) and recommended by Robinette et al. (1974). In the Kelker method a frequency distribution of perpendicular flushing distances is derived from the field data. From this, a determination is made of the perpendicular distance within which there is a reasonable opportunity to observe all of the subject animals, but beyond which some were very likely missed. This distance is then doubled and becomes the width of the observation transect. The formula for calculating density is $N = nA/2LD$ where "N" is the estimated density, "n" is the number of animals seen in the observation transect, "A" is the area being censused, "L" is the length of the transect, and "D" is the estimated perpendicular distance beyond which some animals were probably missed.

Expectations - Studies done on the Kelker method using known populations of objects and animals have shown this method to produce density estimates within 6.8 percent of the true density. In the same report, "t" tests showed that these estimates are not significantly different from the true mean (Robinette et al. 1974).

In order to obtain results of similar accuracy it is necessary to accumulate 30-40 sightings of each species or functional group (e.g., insectivores) whose density is to be estimated (D. R. Anderson, pers. comm). In the vegetation types being studied on the oil shale tract it is expected that the number of sightings will meet or exceed these requirements for particular species or groups (C. V. Grant, pers. comm). Infrequent or rare species will be combined by functional groups to meet the sighting require-

ments. It is expected that density estimates of ± 10 percent of the mean can be generated for a majority of the birds and mammals sampled by this method.

2. Large and Small Trap Grids: Two computations are necessary to generate density estimates from the live-trap grid data. The first step is to estimate the number of animals inhabiting the general sample area. This becomes the numerator in the density formula (i.e. number of animals). The second step is to estimate the exact area being sampled by the grid. This becomes the denominator in the density formula (i.e., unit area).

Several techniques are available to calculate the number of animals. The Schnabel (1938) and Schumacher-Eschmeyer (1943) methods consistently estimate low. These estimates equal or exceed the actual number of animals captured only 13 percent of the time (Anderson, 1975). The Jolley (1965) estimator exceeds the actual number of animals captured only 19 percent of the time (Anderson, 1975).

The various "frequency of capture" estimators, in nearly all cases, estimate more than the number of animals actually captured. Since there is virtually no agreement among these estimators, it is difficult to choose which of them to use. Application of traditional goodness-of-fit tests to these estimators does not aid in decision making. Roff (1973) has shown goodness-of-fit tests to be insensitive in discriminating between different distributions. Therefore, we will follow the precedent set by Krebs (1966), Maza (1974) and Anderson (1975) and use the actual number of animals captured as the numerator in the density estimate. Although this may be a minimum estimate, it represents a known quantity and avoids the ambiguity generated by using computational estimation techniques for which necessary assumptions are not fulfilled.

The second step in calculating density estimates is to estimate the size of the area sampled. Home-range estimates for the abundant species are calculated using an elliptical estimator when there are sufficient recapture data (Jennrich and Turner 1969). For meaningful home-range estimates Anderson (1975) suggests having data from at least 40 different animals captured at three different points not in a straight line. All captures, for as many species as possible, from the entire sample year will be pooled following the August sample period to meet his criteria. The 12 x 12 grid data collected in 1975 and 1976 will also be pooled. For species meeting these criteria the pooled home-range estimate will be converted to a circle. The length of the diameter will be added to each dimension of the 12 x 12 grid to generate the denominator for the density calculation (i.e., unit area sampled) (Turner et al. 1971).

When there are not at least 40 home-range estimates, the grid is expanded by adding twice the mean distance between pooled successive captures to each dimension of the grid (Brant, 1962); and Anderson, 1975).

In the event there are species for which neither home-range nor distance between successive captures can be calculated, the grid will be arbitrarily expanded by adding twice the distance between trap stations to the dimensions of the grid.

Expectations - In the grid sampling program we expect the small 5 x 5 grids, sampled in February, June and August, to provide data on temporal and spatial distributions of the various species, provide an immediate index to relative abundance and contribute home-range data to the data pool. The 12 x 12 grids provide density estimates rather than relative abundance. We expect that they will provide the data to substantiate the findings on the small grids with regard to distributions of

rodents in August; thus, adding confidence to the findings of the February and June sample. Furthermore, the large grids will provide additional recapture data to add to the home-range data pool. It is expected that at the conclusion of the August sample there will be sufficient data to make Jennrich and Turner home-range estimates for all the abundant and common species. Using this combination of methods we expect to generate density estimates for the February and June samples following the conclusion of the entire sampling program.

It is difficult to derive statistical inferences from capture-recapture data. Confidence intervals can be calculated for the home-range. None can be calculated for the numerator of the density estimate, nor is there any certainty about how to apply the home-range information to the denominator of the density formula. Although these problems are generally recognized, solutions are currently lacking. The methods proposed herein, therefore, are the best available and are consistent with current theory and practice.

3. Large Mammal Survey: Sample means, variances and the overall population estimate are calculated by Cochran's formulas shown in Table 6 (Cochran, 1953).

Expectations - Siniff and Skogg (1964) reported population estimates for caribou with 90 percent confidence intervals of 22 percent of the sample mean. We expect the deer census on the oil shale tract to generate estimates with 90 percent confidence intervals of less than $\pm$ 20 percent of the sample mean.

Data from all the elements will be reported and discussed in the two reports described in Section 6.0 (Suspension Period Monitoring). The first report will cover the period December 1, 1976 - April 30, 1977.

Table 6

FORMULAS FOR ESTIMATING VARIANCE AND POPULATION ESTIMATE FROM STRATIFIED RANDOM SAMPLES*

Calculating Variance and Population Estimate

$$S^2_{x_{st}} = \Sigma \frac{Wh^2Sh^2}{nh} - \frac{WhSh^2}{N}$$

Population estimate $X = \bar{X}\ stN$

0.95 confidence limits for population esti

$$X \pm t_{0.05}Ns_{x_{st}}$$

Definitions

Nh	=	Total number of sampling units for each stratum
nh	=	Number of sampling units that were samples from each stratum
$\bar{X}h$	=	Strata means
Sh^2	=	Strata variances
Wh	=	Strata weights (Nh/N)
Vst	=	Variance of stratified mean
$\bar{X}st$	=	Stratified mean per sampling unit
X	=	Estimated population total for study areas
N	=	Total number of sampling units

*From Siniff and Skogg, 1964.

All the data developed during that period will be included in the report. Objectives and methods will be reviewed, and the Interim period data compared to corresponding Baseling data.

The final suspension report will cover the entire December 1, 1976 - October 31, 1977 period. All data collected since the first report will be included. Detailed comparisons of the Interim data to Baseline data will be made. Observations and conclusions will be presended.

In addition, the following hypotheses will be tested:

- 1977 small mammal populations decreased from 1976 levels.
- 1977 bird population increased from 1976 levels.
- The resident deer herd population remained constant in comparison to Baseline periods.
- There are no significant differences in data between control and treatment plots of similar vegetation types.

4.3.2.4 Rationale. Five of the eight flushing transect sites chosen were used during the Baseline program. The three new sites were elected to provide a control/treatment pair for each of the four principal vegetation types.

The four large-grid trapping locations are the same as used during the Baseline program.

Stratified random quadrat sampling was selected for large mammals because it has several advantages over both total area direct-count and sprip-count methods. In the direct-count method, effort per unit area is less for the same cost and there is no way to estimate variance. Strip-count methods are inaccurate because of the inability of observers to define and maintain a constant observation transect width from the air

(Overton and Davis, 1969). The stratified random quadrat method samples smaller areas intensively, generates variance estimators and uses geographic and/or manmade landmarks to define predetermined sample areas. Evans et al. (1966) and Siniff and Skogg (1964) concluded that this method yields realistic and acceptable estimates.

4.3.3 Aquatic Biology

The description of work in this section is copied directly from the USGS Division of Water Resources scope of work description. The program is being done exclusively by the USGS.

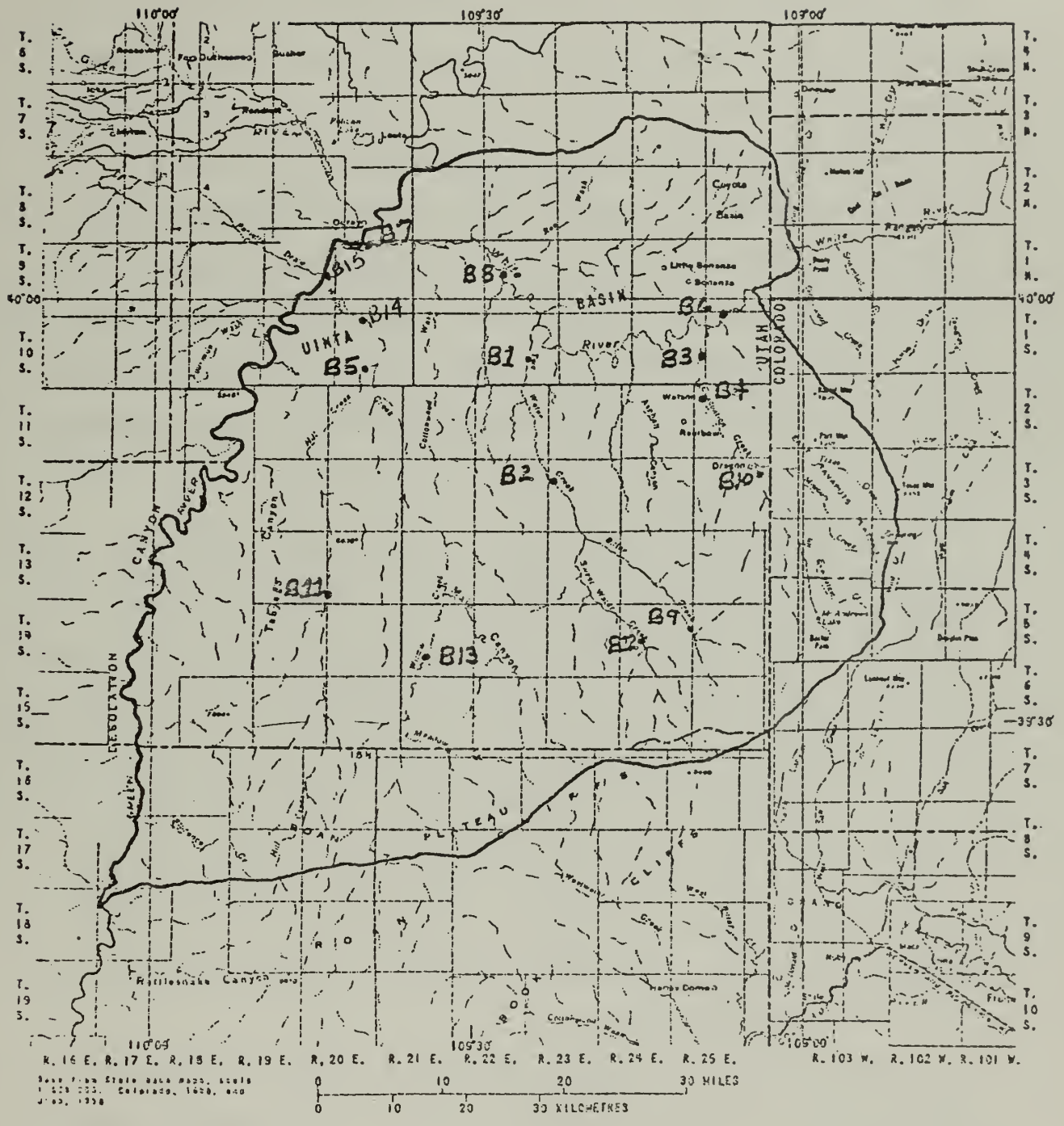
WRSP believes that no aquatic work is required during the suspension period insofar as WRSP interests are concerned. WRSP will, however, follow the USGS work and incorporate program results into the suspension period's reports as information is made available.

4.3.3.1 USGS Program Description. The study area (See Figure 7) is located in the Southeastern Uinta Basin, most of which lies on the East Tavaputs Plateau, or Roan Plateau. The U. S. Geological Survey, Water Resources Division, is presently operating surface water gaging stations on all major drainages within the study area that are tributaries to the Green and White Rivers. Biological samples will be collected at most sites, if not all sites, in conjunction with monthly measurements of stream discharge, chemical quality characteristics and suspended sediment loads.

The program will be divided into two phases. The first phase will be to establish baseline data at existing surface water gaging stations. The second phase will consist of new sampling sites near headwaters and proposed processed shale disposal sites on the basis of an evaluation of

Figure 7

Map of
Sampling Sites



collected data from gaged sites and according to records relative to the pollution potential on disposal sites and virgin conditions near the headwaters.

The occurrence of species or types, and the community composition and concentrations will be determined. The aquatic ecosystem will also be monitored for changes in species types and/or concentrations resulting primarily from human activities in the area. Emphasis will be placed on the biological effects of oil shale production.

The study will include the investigation of 4 major groups of organisms - coliform bacteria, phytoplankton, periphyton, and benthic invertebrates. The suitability of these organisms as indicators of aquatic environmental fluctuations warrant their investigation. At least 10 man-days per month will be required to adequately perform the work involved.

Part 1. Coliform Bacteria

Coliform bacterial are found primarily in feces, though some coliform members exist in soil, water and vegetation. Generally, an appreciable coliform bacteria concentration in water indicates human or animal sewage pollution, and is considered to have disease producing potential. Drinking water standards specify the permissable coliform bacteria concentrations.

Fecal coliform are those members of the coliform group which are found specifically in the intestines of warm-blooded animals. If fecal coliforms are present, pollution is probably quite recent and may be relatively dangerous. (The presence of nonfecal coliforms indicate less recent or nonfecal pollution.)

Fecal streptococci bacteria are used as pollution indicators because their presence verifies fecal contamination, and their relative numbers vary according to the kind of host animal. For instance, the total fecal

coliform to fecal strep ratio, (FC/FS), for human feces may be 4.0 while that of cattle is 0.5. Thus, fecal streptococci can provide a way of determining the exact source of contamination.

In this study, total coliform, fecal coliform and fecal streptococci concentrations will be measured, in order to determine occurrence, intensity and source of the pollution in the streamwaters in Southeastern Uinta Basin.

In general, samples will be taken on a regular basis. Where feasible, sampling should be a least quarterly and preferably monthly. High or remote stations may require a lower sampling frequency. Once expected numbers and locations of coliform bacteria concentration are known, any areas of special interest can be examined in greater detail. Also, after a year or so, it may be possible to reduce the number of stations, or the sampling frequency at some stations, if variations are not significant.

The technique to be used to determine coliform numbers will be the standard count (membrane filter) method. A known quantity of water is taken from a well mixed, even flow (a representative sample) and will be filtered through a membrane filter. The filter will then be placed on a nutrient substrate (broth or agar) and incubated for a certain time period. The incubation time and temperature, and nutrient composition, favor growth of certain bacteria while inhibiting the growth of others. Thus, the specific environment can be used in order to grow a specific bacteria. For instance, to favor total coliform growth, incubation would be 18-24 hrs. at 35°C on MF-Endo agar, while fecal coliform requires 22 hrs. at 44.5°C on M-FC, and fecal strep requires 48 hrs. at 35°C on KF agar.

After the required incubation period, bacterial colonies appear with a color unique to the kind of bacteria present. These colonies are

readily identifiable with a 10X to 20X stereo microscope. Generally, each visible colony represents one individual bacteria in the original sample. With the sample volume known and the number of colonies counted, the bacterial "count" per 100 ml of sample can be determined.

Part 2. Phytoplankton

Plankton are defined as microscopic organisms suspended in a body of water, drifting with limited mobility in the direction of the flow of water. Phytoplankton are the plant portion of the plankton community. Phytoplankton utilize sunlight to convert inorganic nutrients into complex organic compounds. Emphasis will be placed on phytoplankton because of a direct relationship between this group and concentrations of dissolved oxygen, Ph, and certain solutes.

At each site, the phytoplankton will be sampled taking a one liter sample at the centroid of flow, using a depth integrated sampler. For small streams, the samples will be collected at a given point in a single transverse. The samples will then be preserved and stored for identification.

Bi-monthly sampling will be completed in the spring and fall and monthly in the summer and winter. A reduction in the sampling frequency and the total number of sampling sites will occur in the event data becomes repititous.

Many variations occur in the Phytoplankton community that make sampling procedures varied. The organisms may be few in number requiring the investigation to view many slides to obtain an accurate count. They also may be so numerous that dilution is necessary before a count can be made. The analysis of samples collected will be performed using the Sedgwick-Rafter method, as described by Slack and others (1973). The

method is performed easily with fairly good accuracy using a calibrated microscope and a measuring eyepiece, such as a Whipple eyepiece.

Part 3. Periphyton

The plants and animals that colonize and live upon submerged objects are referred to as Periphyton. While algae is the most visable portion of the community, the total composite population, plant and animal portions together must be analyzed to obtain an accurate account of the Periphyton community. Algae is one of the most important primary producers in the Aquatic ecosystem, contributing greatly to the dissolved oxygen in the system. Any fluctuation in the algae community would have an effect on dissolved oxygen available and other organisms. Environmental changes have been recorded by using the ratio of the organic dry weight of a known surface of periphyton (organic biomass) to the plant pigment (chlorophyll a). this procedure is called the biomass pigment ratio or autotrophic index. Procedures used in determining the autotrophic index are described in Slack and others (1973), pp. 91-92).

Artifical substrates will be used in the collection of periphyton. The time required for adequate colonization depends upon the season, water temperature, light and availability of nutrients. Sufficient growth is indicated by a visible green or brown color. After sufficient growth has occurred, approximately 30 days, the substrates will be pulled and shipped to the WRD Hydrobiological Laboratory at Doraville, Georgia.

Part 4. Benthic Invertebrates

Animals inhabiting the bottoms of streams and lakes are referred to as benthic invertebrates. They include insects, crustaceans, roundworms, flatworms, annelids, and molluscs. As a major link in the aquatic food

chain, the health of the benthic community is reflected in the well-being of higher aquatic animals.

Three life characteristics of this group of animals allow them to be used as good aquatic biological indicators of fluctuations in water quality. The characteristics are: first, long life span, requiring adaption to long-term environmental changes; second, size of the individuals, facilitating identification; and third, limited mobility, restricting organisms to certain environmental habitats. A fluctuation in pollutant intensity may alter species composition. Therefore, a knowledge of taxonomic groups, to genera, will be helpful in determining trends in water quality.

The sampling frequency will be monthly. The techniques are those described in Slack and others (1973). Different procedures will be used to determine which techniques will result in the most accurate data. Faunal surveys will be the basic form used to determine species diversity and relative population totals of each species. Sampling sites will include horizontal and vertical cross sections of riffles and pools. Statistical methods will be used in determining results of collected data.

Section 5.0

REVEGETATION RESEARCH PROGRAM

No one has yet demonstrated vegetation techniques in regard to processed Utah oil shale. Work to date has been confined to Colorado oil shale. WRSP, therefore, initiated a research program in 1975 to develop a technique for the revegetation of processed oil shale on Tract Ua/Ub.

In 1975 the Range Science Department of Utah State University was placed under contract to investigate revegetation of processed shale as well as the rehabilitation of disturbed sites. Dr. C. M. McKell is the principal investigator. The work is expected to be completed by December 1978.

5.1 OBJECTIVES

The objective of this research is to develop a technology utilizing native plant species for revegetating distrubed sites and processed shale disposal area.

5.2 RESEARCH APPROACH

The scientific approach proposed in the revegetation study is based on several important facts or conditions:

1. Plants used in rehabilitating distrubed areas and processed shale disposal sites must be adapted to and persist under the existing environmental conditions.

2. Water is a scarce resource in the oil shale area and any use of it for revegetation must be minimal.

3. Salinity is a serious problem of the processed shale, not only from the aspect of plant establishment and

persistence in soils of high salinity but also from the aspect of avoiding saline leachates into the Colorado River system.

4. Surface dust will be a problem in some areas and must be settled or kept minimal.

5. Revegetation of salt desert ecosystems with exotic grass species in previous work has not been successful.

The various strategies proposed for revegetation of disturbed sites and processed shale deposit areas must take into account the above conditions. Native species of the immediate area, particularly shrubs, are being studied for the best means of propagation or planting either by seed or rooting of cuttings. Soil surface sealing materials are under study for their ability to collect water and shed it onto areas where plants have been transplanted, thus not only reducing the requirement for irrigation but also stabilizing surface particles and reducing dust. Salinity problems can be minimized by the use of salinity-tolerant native shrubs such as saltbush (Atriplex) and greasewood (Sarcobatus).

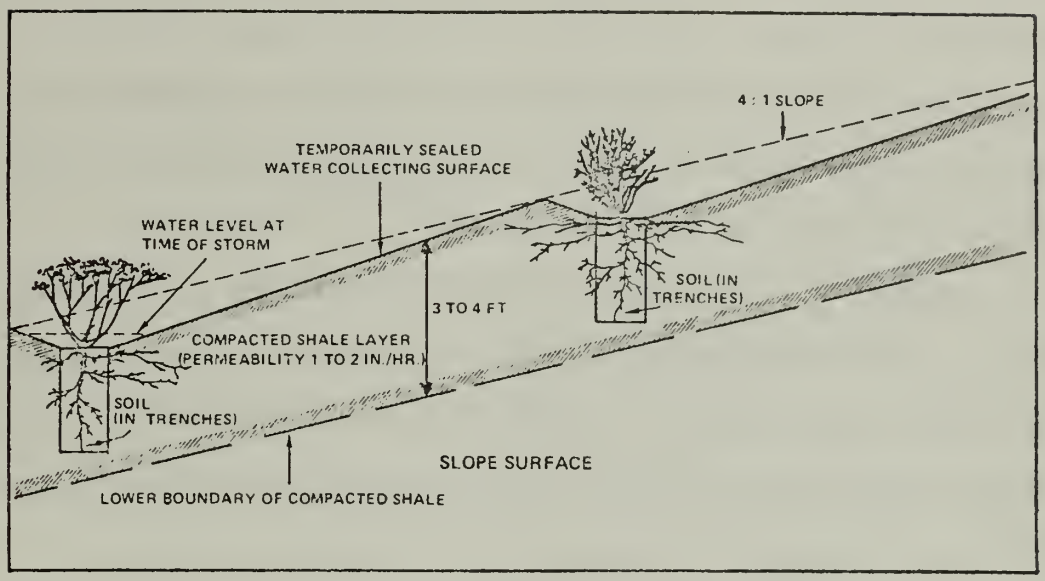
In addition, minimal irrigation, if necessary, should not be applied to the extent that it would leach salts into the hydrologic system. Transplanted species will be placed in trenches or "post holes" filled with topsoil, thus minimizing the need for expensive stockpiling of topsoil. Diagramatically, the revegetation system would appear as in Figure 8, either for slopes or flat areas.

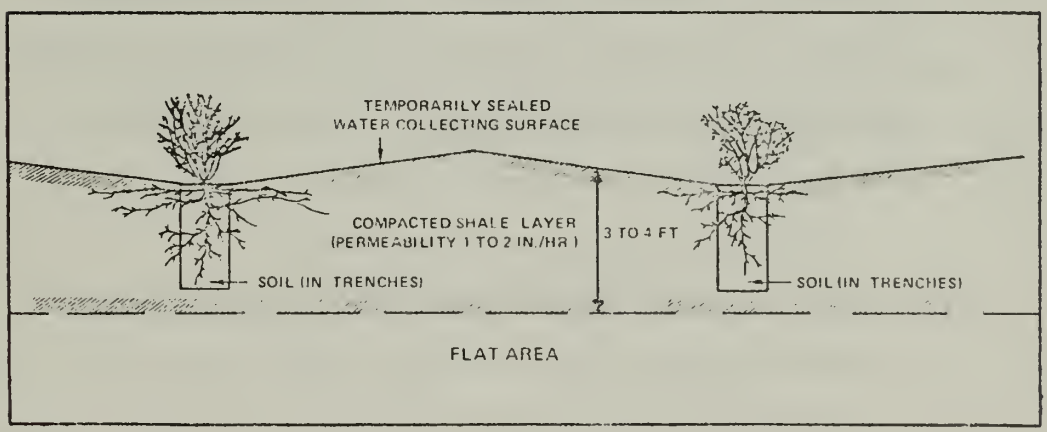
Water from collected rainfall will irrigate the volume of topsoil and leach salts down and out as it moves through the soil column. Size of basin or collecting area would be made appropriate to the calculated water needs of the plant and the leaching requirements set up by the soil column.

As the soil surface treatment breaks down over time, annual and perennial plants are expected to colonize the area immediately around the

Figure 8

SURFACE MODIFICATION AND VEGETATION ON
PROCESSED SHALE (CONCEPTUAL - NOT TO SCALE)





planted shrubs/grasses and gradually cover the soil surface. The transplanted species will provide a major source of seed for subsequent revegetation of the disturbed areas.

The foregoing process draws, as much as possible, upon research already reported in the literature or underway in various locations. Much of the previous work is anadequate, however, to deal with the problems presented by the spent shale or the salt desert ecosystem of the Ua/Ub region. Some innovation in combining the results of previous work and some new research is needed. None of the research being done by WRSP will duplicate that which has already been done.

A number of studies have already been initiated or planned in some detail. A few results have been obtained which were reported in June 1976. (See "Third Progress Report -- Revegetation Studies for Distrubed Areas and Processed Shale Disposal Sites") The study work consists of the following tasks:

A. Expand disturbed-site revegetation studies

In April 1975 a replicated study involving eight species of native shrubs were planted at four sites disturbed by drilling operations. A total of over 900 shrub seedlings, one to two years old, were used. This study will be followed to obtain data on the results.

Studies planned or underway include:

1. fall seeding of shrubs, forbs, and grasses;
2. spring seeding of shrubs, forbs, and grasses; and
3. spring transplants of tubelings of rooted cuttings and seedlings.

B. Studies or hormone treatments for stimulating native shrub cuttings to produce roots at two spring collection times. (The first phase of this study was finished by July 1976.) Additional cuttings were obtained in the fall for comparison to determine the best time of year to obtain cuttings.

C. Evaluate soil surface stabilizing materials for effectiveness, longevity and water sheding ability. Six materials were set out in mid-June 1975 on two sites. Two replicates were on natural soil surface and two on spent shale. Soil moisture conservation and plant survival will also be evaluated.

D. Slopes and basins were treated with the most promising materials identified in experiment C. These were done in various sizes and slopes to determine the amount of water that can be collected. General observations of mechanical problems will be undertaken. Experimentation with spent shale is being undertaken. Problems of salt movement both by leaching and by upward evaporation will be studied.

E. Collect seeds of native plants. Adequate collections of all principal species will be made, cataloged and stored in a cool-temperature room for future use. The phenologically optimum time for collection, method of collection, and cleaning problems will be documented.

F. A collection of unique plants and ecotypes and a demonstration nursery was assembled on the research site in Section 6.

G. Root growth of salt-tolerant shrub/grass seedlings in spent shale will be studied in field and greenhouse. A preliminary study is presently underway using containers of crushed shale with a core of native soil and a seedling in the center. Further studies will depend on the results of ongoing work.

H. Containerized plant studies. Several studies to work out details of plant growth under container conditions are underway or planned. Some of the questions to be answered include:

- time required in container for best root growth
- fertility requirement
- container size
- early plant material preparation
- transplant seedling, cutting, direct seeding.

Results from these studies will be used to develop a set of criteria and guidelines for growing cuttings and seedlings of native plants suitable for transplanting uses.

I. Evaluate the suitability of native shrubs, trees, and perennial herbs for low maintenance landscaping (in new town and other uses).

J. Develop studies of revegetation problems in response to requirements as indicated in the Detailed Development Plan.

The program utilizes physical facilities at Utah State University and the Snow College Field Station. A field test site has also been established on property in Section 6, T9S, R25E. In conjunction with these locations disturbed drill pad locations on Tract Ua/Ub have been used for test planting purposes.

Revegetation research is expected to continue for many years. The objectives of the program discussed in this section, however, should be met by December 30, 1978. Future work requirements and timing will be dictated by the results of this program and the timing of development operations on Tract Ua/Ub.

5.3 RESULTS

The study progress and results determined through June 30, 1976 have been previously published in Quarterly Baseline Report and more specifically in the following documents (both of which have been delivered to the AOSS).

1. "Third Progress Report (1/1/76 - 6/30/76) Revegetation Studies for Disturbed Areas and Processed Shale Disposal Sites" by Utah State University, (Dr. C. M. McKell principal investigator).

2. "Achieving Effective Revegetation of Disposed Processed Oil Shale: A Program Emphasizing Natural Methods in an Arid Environment." May 1976: Land Rehabilitation Series No. 1, Agricultural Experimental Station, Utah State University (Dr. C. M. McKell).

Appendix B presents the table of contents and "highlights" from document #1 above. This is presented to show the scope of the research effort.

5.4 REPORTS

The next Revegetation Program Progress Report (June - December 1976) will be available in early 1977. It will be included in the Progress Report on lease suspension activities (See Section 6.0 - Suspension Period Reports).

The report covering the period January - June 1977 will be included in the Final Report covering the suspension period.

Section 6.0

SUSPENSION PERIOD REPORTS

Two reports will be submitted concerning the suspension period besides the Final Environmental Baseline Report. The first will be the "Progress Report -- Lease Suspension Period Environmental Programs," and the second will be the "Final Report -- Lease Suspension Period Environmental Programs."

This section will discuss the objectives and format for these two reports.

6.1 PROGRESS REPORT

The "Progress Report -- Lease Suspension Period Environmental Programs" will cover the period November 1, 1976 to April 30, 1977. In the case of Water Resources, however, it will also include the period October 1, 1976 to October 31, 1976 (See Section 4.1).

The report is planned for submission to AOSS by July 15, 1977.

6.1.1 Objectives

The major objectives of this report are to transmit data and to discuss the status of the respective environmental programs.

6.1.2 Format

The report manner of presentation will follow the general format of the Work Plan (See Table 7). Within this framework program objectives

Table 7

SUSPENSION PERIOD REPORT FORMAT

1.0 SUMMARY

2.0 INTRODUCTION

3.0 BASELINE ENVIRONMENTAL MONITORING PROGRAM

4.0 INTERIM ENVIRONMENTAL MONITORING PROGRAM

- 4.1 Water Resources
  - 4.1.1 Surface Water
  - 4.1.2 Deep Aquifer Water
  - 4.1.3 Alluvial Water
  - 4.1.4 Precipitation/Evaporation
- 4.2 Air Resources
  - 4.2.1 Air Quality
  - 4.2.2 Meteorology
- 4.3 Biological Resources
  - 4.3.1 Vegetation
  - 4.3.2 Terrestrial Vertebrates
  - 4.3.3 Aquatic Biology

5.0 REVEGETATION PROGRAM

and methodology will be reviewed. Changes required from the Work Plan in any area will be discussed. The status and future work plans of the programs will be discussed.

All data available at report preparation time will be provided in a "field data package" which will accompany the Progress Report. The data will be briefly summarized and compared to applicable Baseline Program data. No detailed data analysis or comparisons will be made.

6.2 FINAL REPORT

The "Final Report -- Lease Suspension Environmental Programs" will cover the entire suspension period of November 1, 1976 to October 31, 1977; plus October 1, 1976 - October 31, 1976 in the case of Water Resources.

The report is planned for submission to the AOSS by May 1, 1978.

6.2.1 Objectives

The major objectives of this report are to transmit the remainder of the Suspension Period data and to compare the Interim Period monitoring results to the two-year Baseline Period data.

Other objectives include the establishment of a basis for modifying future monitoring programs, the transmittal of results and progress of the Revegetation Study, and reporting on the status of the ongoing review of the Baseline Period data.

6.2.2 Format

The report manner of presentation will follow the general format of the Work Plan and Progress Report (See Table 7).

The objectives and methodology of the various programs will be reviewed. Success in reaching the objectives and changes in methodology from those presented in the Work Plan will be discussed. Status of ongoing programs will be reviewed.

All data collected during the suspension period not previously transmitted will be included as a "field data package" which will accompany the Final Report. The data will be summarized and discussed in detail.

The data collected during the Interim Monitoring Program Period (Section 4.0) will be rigorously compared to that collected during applicable Baseline periods. Differences will be discussed and explanations proposed. The results of the hypotheses tests proposed in the Work Plan will be presented and discussed. Conclusions regarding future monitoring needs will be made and reviewed in the Final Report.

Although only two reports are going to be submitted concerning the Lease Suspension Period, WRSP will be prepared at any time to discuss progress, problems and results to date with AOSS and others.

Appendix A

FINAL ENVIRONMENTAL BASELINE REPORT

OUTLINE (DRAFT)

I. INTRODUCTION

II. WATER RESOURCES

- A. Surface Water Hydrology
  - 1. Hydrology
    - a. Methodology
    - b. Summary of Results
    - c. Interpretation and Conclusions
  - 2. Summary of Water Quality
    - a. Methodology
    - b. Summary of Results
    - c. Interpretation and Conclusions
  - 3. Evaluation of Baseline Program
- B. Ground Water Hydrology
  - 1. Methodology
  - 2. Summary of Results
    - a. Occurrence
    - b. Aquifers
    - c. Recharge
    - d. Movement and Fluctuation
    - e. Discharge
    - f. Storage and Change in Storage
    - g. Quality
    - h. Use
    - i. Moisture Monitoring
  - 3. Interpretation and Conclusions
  - 4. Evaluation of Baseline Program
- C. Glossary
- D. References
- E. Appendices

III. AIR RESOURCES

A. Meteorology

1. Surface Meteorology

a. Methodology
b. Summary of Results
c. Interpretation and Conclusions

2. Upper Air Meteorology

a. Methodology
b. Summary of Results
c. Interpretation and Conclusions

3. Evaluation of Baseline Program

B. Diffusivity

1. Methodology

2. Summary of Results

3. Interpretation and Conclusions

4. Evaluation of Baseline Program

C. Air Quality

1. Gaseous Pollutants

a. Methodology
b. Summary of Results
c. Interpretation and Conclusions

2. Particulates and Trace Metals

a. Methodology
b. Summary of Results
c. Interpretation and Conclusions

3. Visibility

a. Methodology
b. Summary of Results
c. Interpretation and Conclusions

4. Evaluation of Baseline Program

D. Radioactivity

1. Methodology

2. Summary of Results

3. Interpretation and Conclusions

4. Evaluation of Baseline Program

E. Sound Levels

1. Methodology

2. Summary of Results

3. Interpretation and Conclusions

4. Evaluation of Baseline Program

F. Glossary

G. References

IV. BIOLOGICAL RESOURCES

A. Vegetation

1. Community Structure and Composition

a. Methodology
b. Summary of Results
c. Interpretation and Conclusions

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THIRD PROGRESS REPORT

January 1, 1976 - June 30, 1976

REVEGETATION STUDIES FOR DISTURBED AREAS AND PROCESSED SHALE DISPOSAL SITES

Submitted by

Utah State University
Agricultural Experiment Station

To

White River Shale Project

Emphasizing Federal Oil Shale Prototype
Leasing Program Requirements, Utah Tracts Ua, Ub

Prepared By: C. M. McKell, Professor of Range Science
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Third Progress Report

Revegetation Studies for Disturbed Areas
and Processed Shale Disposal Sites

I. HIGHLIGHTS OF SIX-MONTH REPORT

The tempo of research activity during the past six months has been fast. Greenhouse and laboratory studies were developed in answer to questions raised from field observations in the fall. The availability of Paraho-processed shale in late October made it possible to develop a number of exploratory studies in the greenhouse. Plans for a major field season prompted us to propagate a large number of plants and prepare them for spring plants.

A high priority for writing a "state-of-the-art" paper on rehabilitating processed oil shale using native species with a minimum of cultural treatments required us to defer completion of the literature review of research relevant to rehabilitating processed oil shale. The report, prepared as a supporting document to the DDP, is in a sense our literature review although we still plan to complete the draft that was prepared earlier.

As soon as weather permitted, a major field planting effort took place in April. Subsequently, other studies have been initiated. Specific areas of effort are described briefly in the following paragraphs.

A. A bibliography on the propagation and establishment of perennial *Atriplex* was prepared by Mr. Kent Crofts as an adjunct to another project of the Institute for Land Rehabilitation. This bibliography will be useful in developing methods for using the three saltbush species native to the oil shale area for revegetating processed oil shale disposal areas.

B. Germination of *Atriplex* seeds is conditioned by the hard, thick utricle that encloses the seed. Seedling vigor appears to be related to seed size and utricle characteristics. Selection of small but filled seeds and thin-walled utricles should increase establishment success with local species of *Atriplex*.

C. Native shrubs grown in containers appear to be conditioned by the size and configuration of the container itself. During the greenhouse phase of a study, plant height appeared to be correlated with the volume of the container. Whether rooting characteristics of individual species are changed significnatly by container size and shape will be tested in the field phase of the study during the next ten months.

D. Physiological studies indicate that several native shrub species grow well on fertilized, raw and processed oil shale with pH values up to 9. Higher pH's (e.g., 11.7 in one sample) inhibit plant growth. Shadscale and fourwing saltbush tolerate high salinity levels (osmotic potentials up to -25 atm) of NaCl and Na_2SO_4. Growth of shadscale is even enhanced by moderate salinity (-10 atm). Several species respond differently to different forms of nitrogen fertilizer (nitrate vs. ammonium) in processed oil shale and the responses are conditioned by the pH and salinity levels of the processed oil shale.

E. Rehabilitation plantings on disturbed sites have shown that superior results may be obtained by planting container-grown plants. Not all of the native species found on the oil shale tracts are suitable for any disturbed site. Soil texture, salinity, competing weeds and depth of bedrock may all dictate the choice of species for transplanting. A current study is

designed to test the best season and planting methods for use in the area of oil shale in Utah.

F. Propagation of big sagebrush (*Artemisia tridentata*) by vegetative means is most effective in the spring when plant materials are still in a dormant stage. High rates of rooting hormone are necessary to promote rooting. Not all plants will root with the same degree of success; careful selection is necessary.

G. Three research proposals were prepared during the last six-month period. If funded, these proposals would expand our scope of research on oil shale in Utah. In addition to the proposals, three reports were published during the same period.

H. Plans for work in the next six-month period include development of a small pilot model of a processed shale pile. This study will help to determine water runoff, percolation, salinity movement and accumulation in the top three to four feet of a disposal pile. Other field studies will investigate soil surface stabilizing materials, root growth of container-grown plants and survival of plants outplanted in fall and spring. Laboratory studies will concentrate on plant growth on processed oil shale in relation to various salts and means to ameliorate the adverse effects of salinity and low fertility.

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(June 1984)

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